AGRICULTURAL ENGINEERING

JUNE • 1954

In this Issue . . .

ASAE 47th Annual Meeting • Minneapolis, Minn., June 20-23

THE JOURNAL OF THE
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Conservation Methods
Made Easy... Economical

Pasture Renovation Harrow has 24 or 26-inch blades spaced 10½ inches apart to bite deep in hard, sod-bound, overgrown soil. Makes way for lush grass on rough, stony, stumpy land.

Field Shredder slashes and beats trash into bits, to remain as mulch or mix with soil for humus formation. Shreds corn and cotton stalks, potato vines, sage brush, other wild growth and crop residues.

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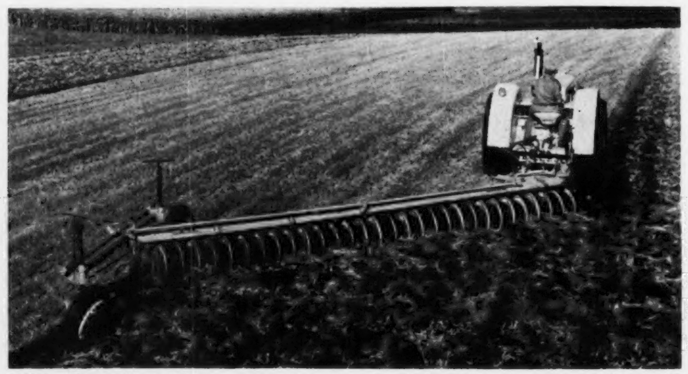
Six-Cylinder... 5-Plow CASE DIESEL Tractor



Wide One-Way Plow turns soil to receive and retain rain, sets stubble to resist blowing, hold soil and snow. Sizes to cut 12, 15, or 18 feet wide, easily adjust to trail for transport. Tandem rear wheels, one running on unplowed land, the other in furrow, give positive depth control in uneven ground.

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AGRICULTURAL ENGINEERING

Established 1920

CONTENTS • JUNE, 1954 • VOL. 35, NO. 6

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RAYMOND OLNEY
Editor and Publisher

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A report to you about men and machines that help maintain International Harvester leadership

HOW THE NEW McCormick® FARMALL® provides the greatest flexibility in power application ever built into a farm tractor

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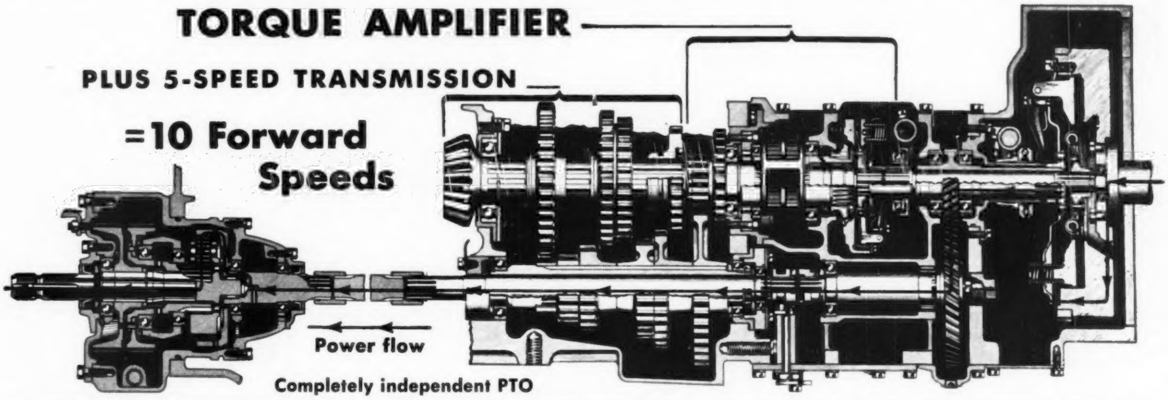
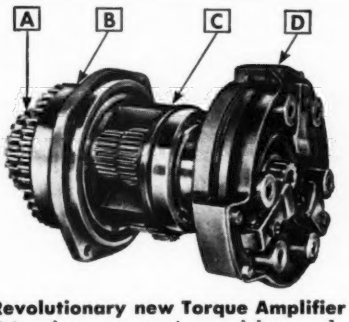
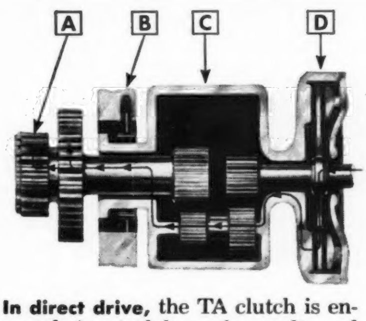
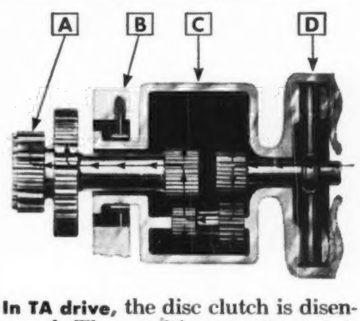




Revolutionary new Torque Amplifier drive is a compact, precision-made speed reduction unit employing planetary gearing. Principal parts are (A) transmission drive gear, (B) cam roller overrunning clutch, (C) planetary gearing, and (D) single-disc dry clutch. The TA unit may be engaged or disengaged with tractor moving or standing still.



In direct drive, the TA clutch is engaged (control lever forward) and the entire TA unit including input shaft, carrier, planetary gearing and transmission drive gear revolve in the same direction, and at the same speed as the engine crankshaft. With TA in direct drive, regular transmission speeds are obtained.



In TA drive, the disc clutch is disengaged. The resulting counter rotating force causes the cam roller clutch to engage automatically, preventing the TA unit from rotating. TA planetary gearing then reduces speed in any transmission gear by 32.4 per cent, boosting pull-power up to 45 per cent and adding a second speed to each regular gear.

IH engineering teamwork produced the new Farmall Super M-TA with Torque Amplifier drive and completely independent power take-off. IH research, engineering and manufacturing men are constantly pooling time and talent to provide equipment that makes the farmer's work easier.

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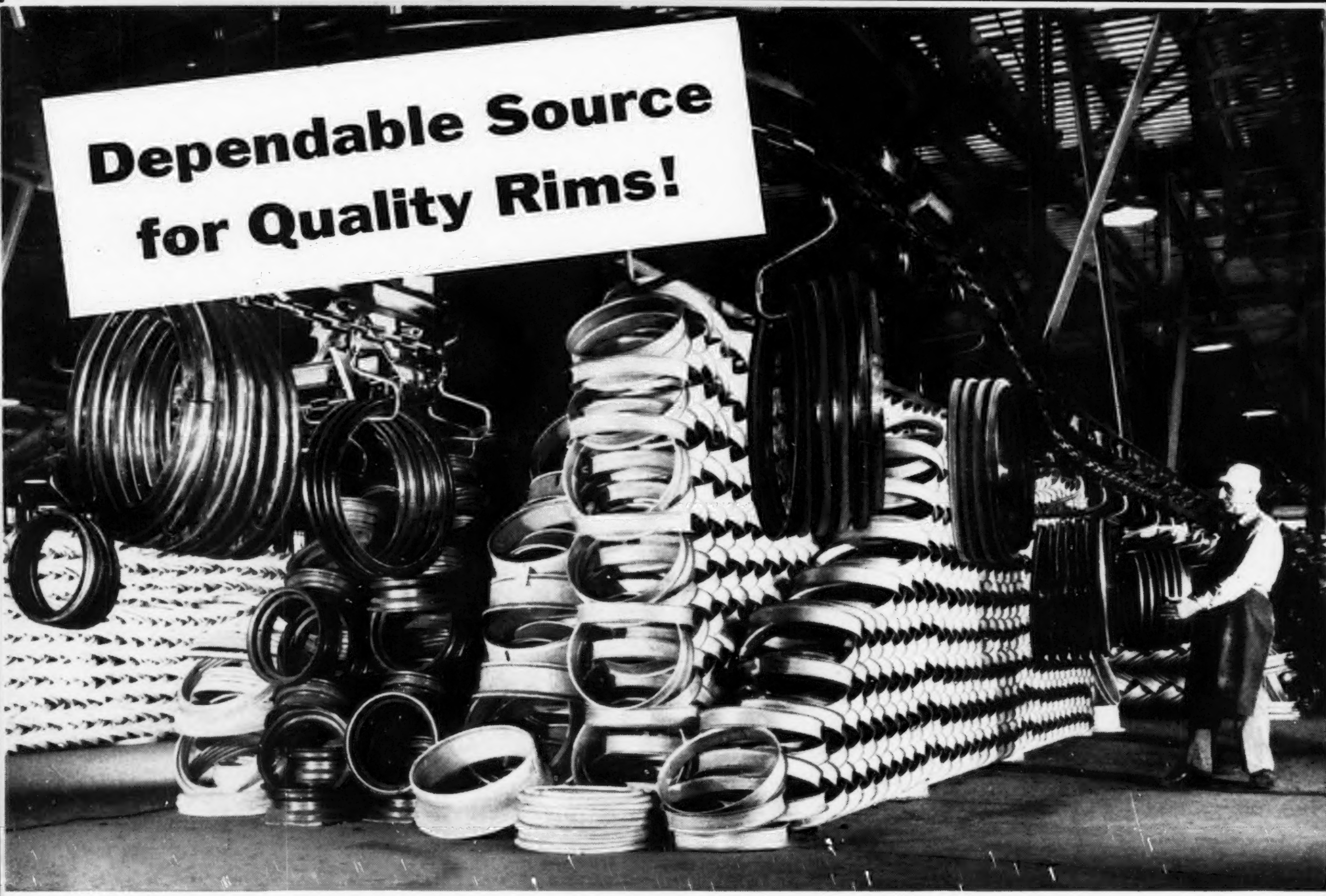

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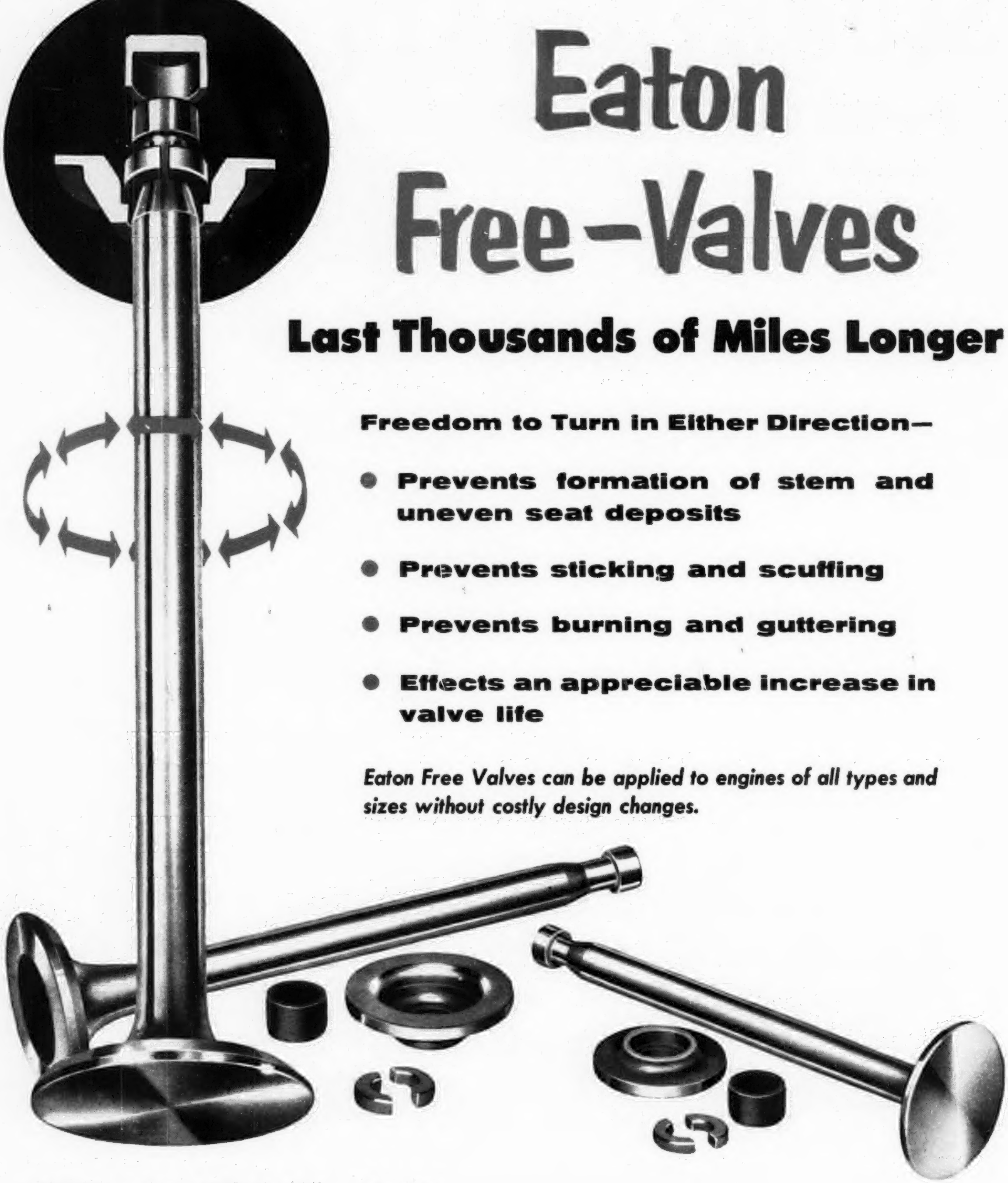

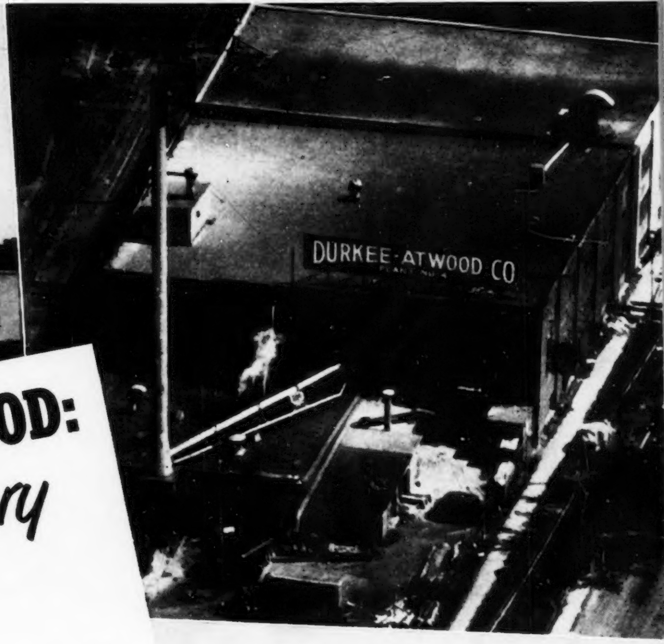

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● BACK IN 1910, two young salesmen put an idea into action. A. F. Durkee and H. C. Atwood pooled their resources and started a company to sell specialty products to the new and booming automotive industry.

Within four years, their little store on Washington Avenue was outgrown, so they built their own plant. Then E. P. Atwood finished college and went to work in the firm —which continued its steady growth. By the middle 1920's, they had acquired two new plants in Minneapolis, another in Red Wing, and were building a quality line of rubber products for automobiles . . . frost shields, fan belts, inner tubes, radiator hose. Later, they successfully invaded the intensely competitive industrial V-belt field.

Today, with five high-production plants and 600 employees, Durkee-Atwood is an acknowledged leader in every field they have entered.

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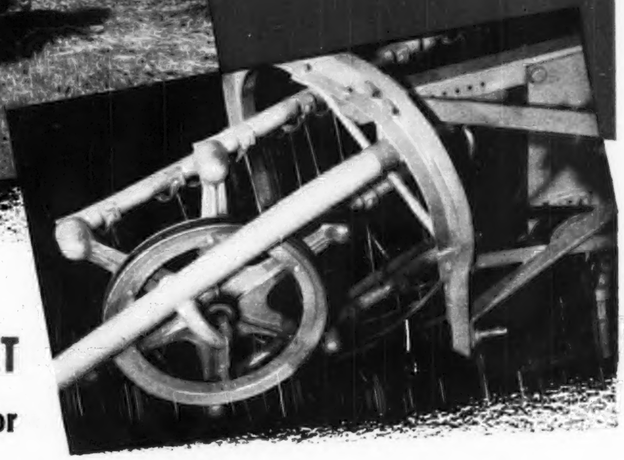

DURKEE-ATWOOD V-BELT

Simplifies Power Transmission for Ferguson Side-Delivery Rake

The Ferguson Side-Delivery Rake is unit-mounted on the tractor and driven from the power take-off by a single Durkee-Atwood V-Belt. This drives the right-hand reel spider with no cams, gears or chains to wear out or cause trouble, and eliminates the ground drive with its usual slippage and complicated moving, driving and wearing mechanisms.

The six-bar reel and special offset placement of bars permits raking at speeds up to 10 miles per hour. Should the reel become jammed accidentally, the V-belt drive allows sufficient slippage for protection.

D-A ENGINEERING Integrates the V-Belt with the Application

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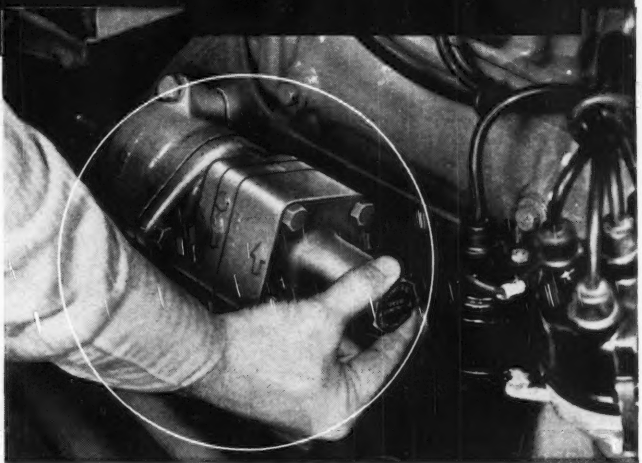
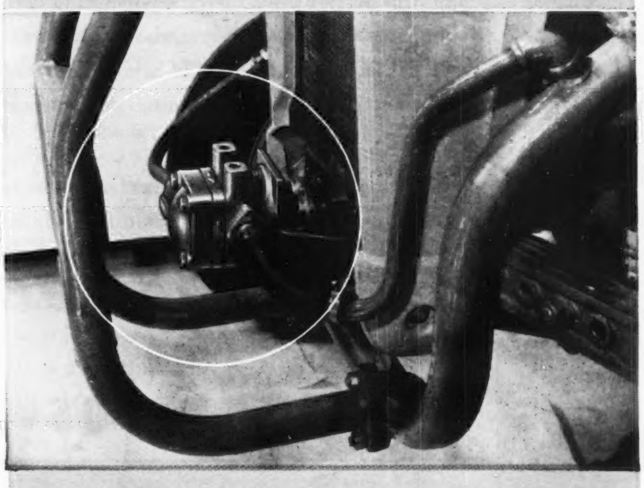
A Vickers Pump on the hydraulic system is the mark of a tractor that will do more and better work with less effort and maintenance. For further information, get in touch with the Vickers Application Engineering Office nearest you.



Vickers® Pump with hand adjustment to vary rate of oil flow as desired at normal engine speed. Pump is engine driven and hydraulic power is available with clutch disengaged.



Power for heavy-duty loader is supplied by this separate Vickers Pump mounted on front end drive (radiator grille removed.)

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People who look for quality look for VICKERS

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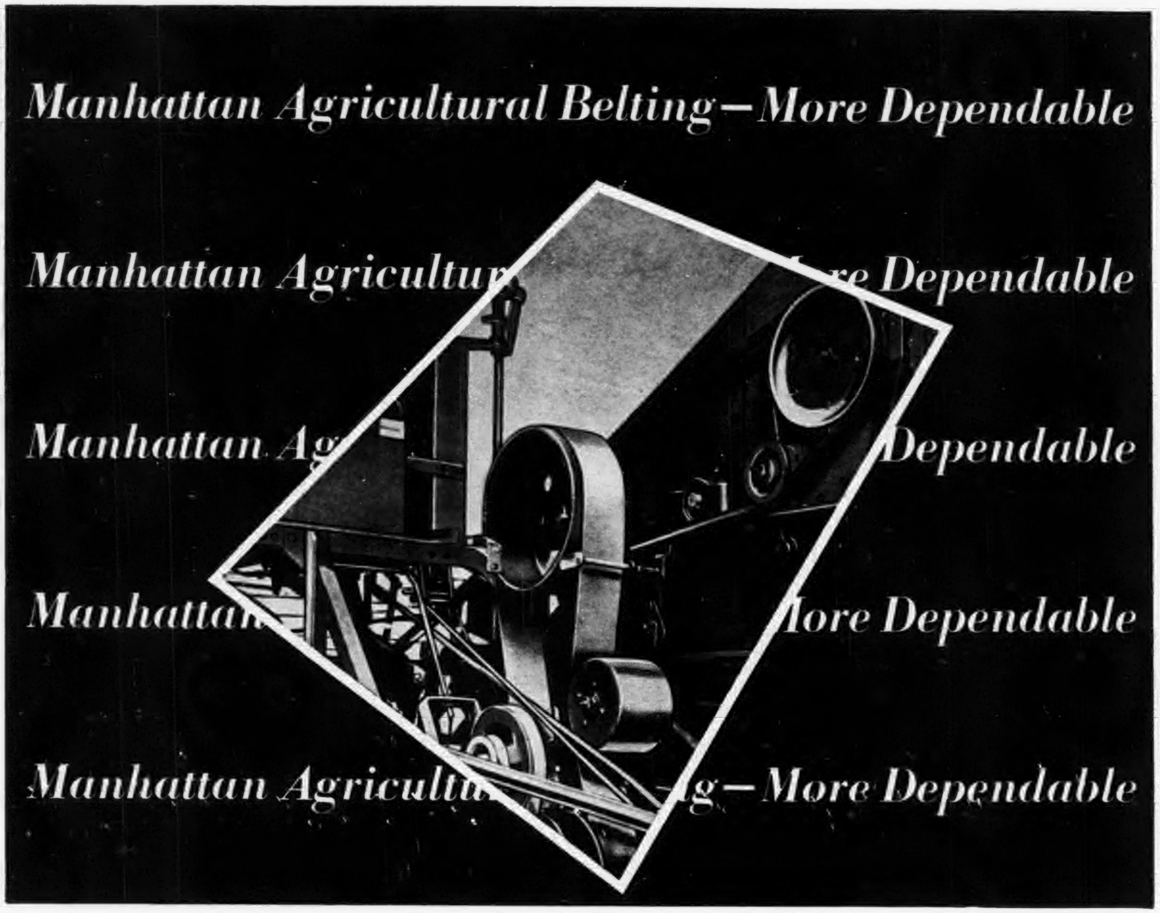
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



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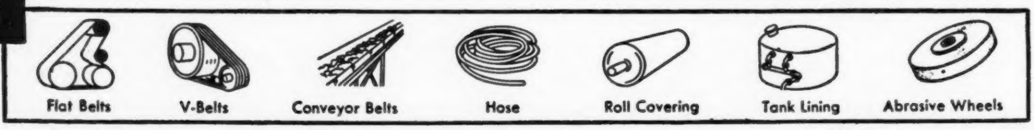

Other R/M products include: Industrial Rubber • Fan Belts • Radiator Hose • Brake Linings • Brake Blocks • Clutch Facings
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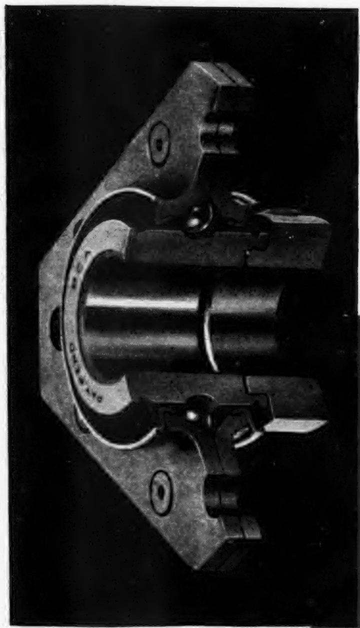

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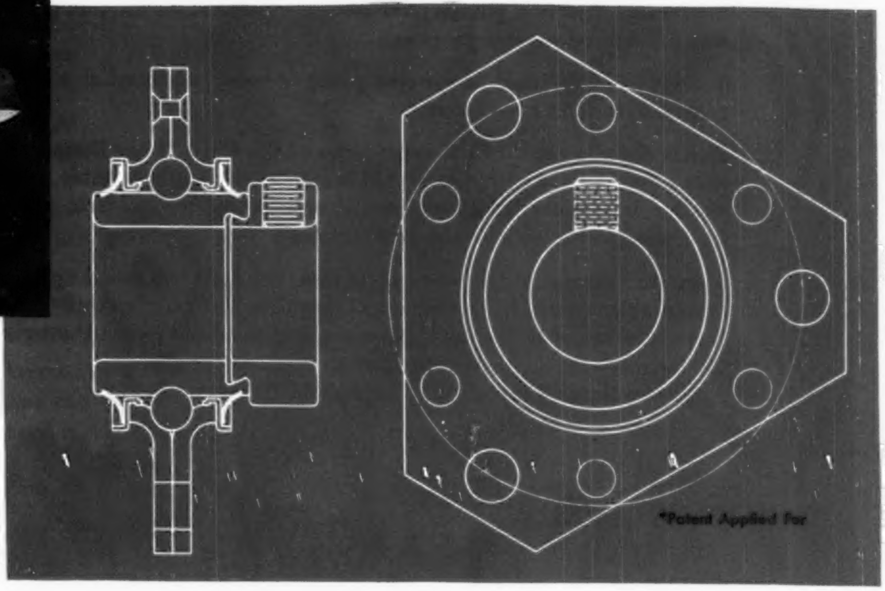

BCA Flange Bearings are low-cost, pre-lubricated *package units.* The two halves of the bearing outer rings are formed into a husky flange with three evenly spaced bolt holes, and the design of the bearing permits some misalignment of equipment members. The extended end of the inner ring is machined to mate with an eccentric lock ring: a twist of this eccentric ring locks the bearing to the shaft without the need for machining the shaft—even when "commercial" shafting is used.

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BCA Flange Bearings are typical of the line of economical, compact bearing units developed by BCA to meet the requirements of the makers and users of farm equipment. Write for additional information.

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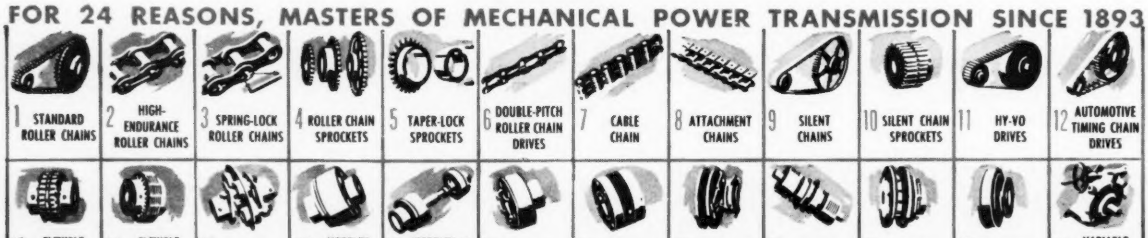

AGRICULTURAL ENGINEERING

VOL. 35 JUNE, 1954 NO. 6

Graphic Presentation of Mathematical Equations

John R. Davis and Carl W. Hall
Member ASAE Member ASAE

Saving of time and increasing accuracy of solutions made possible by this engineering tool

IMPROVING efficiency and work habits in this area of our rapidly expanding technological society involves conserving mental effort and labor and utilizing the efforts and skills of persons with less technical training. Agricultural engineers continually strive to attain these objectives by working together, by standardizing certain practices and specifications, and by studying newer developments and aids in all fields of engineering and agriculture. The purpose of this paper is to point up the merits and uses of various graphical methods of expression as one method of attaining these objectives. The slide rule and sets of tables are common aids for improving the efficiency and usefulness of equations, but because of their inherent inefficiency in repeated computations, graphical devices are coming into wider use. The ability to competently express ideas and the results of experiments to both technical and non-technical audiences is considerably enhanced by the proper use of graphical methods of expression.

Graphical solutions, such as alignment charts or nomographs, special slide rules, and graphical calculus, may be employed to considerable advantage. Alignment charts require less time and there is less likelihood of errors than with the use of the ordinary slide rule or other conventional methods. Alignment charts are easily constructed and interpreted and can be made to almost any desired size or accuracy. The accurate solution of an equation can be standardized regardless of the training of the individuals using these charts. The use of alignment charts does not indicate a softening or lowering of engineering standards, but it provides facilities for making better use of available information and permits work of a more productive nature.

Not all graphical solutions have the advantages just mentioned. Engineers must realize that the use of graphical solutions may not be adapted for all equations and presentations of data. Some graphical solutions, such as network charts, are often cumbersome and difficult to interpret. If the data or equations are to be used repeatedly, alignment charts have a distinct advantage. On the other hand, if the data are to represent trends and simple relationships and are not to be used for repeated solutions, the common, simple graph may be better. Regardless of the method used, it should contain the desired efficiency and clearness of presentation. Engineers should investigate thoroughly all the possibilities of presenting data in order to select the most suitable method.

A frequent criticism of illustrative material used at technical meetings is that of general illegibility and poor design and arrangement of data. Use of graphical methods provides part of the answer to this problem, because this method of presenting data is neat, concise, and attractive. Students and staff personnel of college agricultural engineering departments should be impressed with the importance of clear presentation of data, because often it may reflect on the individual presenting the paper.

The authors recommend that in the undergraduate agricultural engineering curriculum, and definitely in the graduate program, time be devoted to graphical solutions. The procedure involved in graphical analysis is not

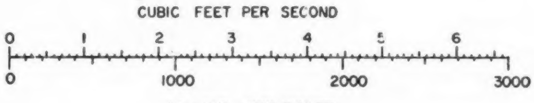

Fig. 1 Conversion chart

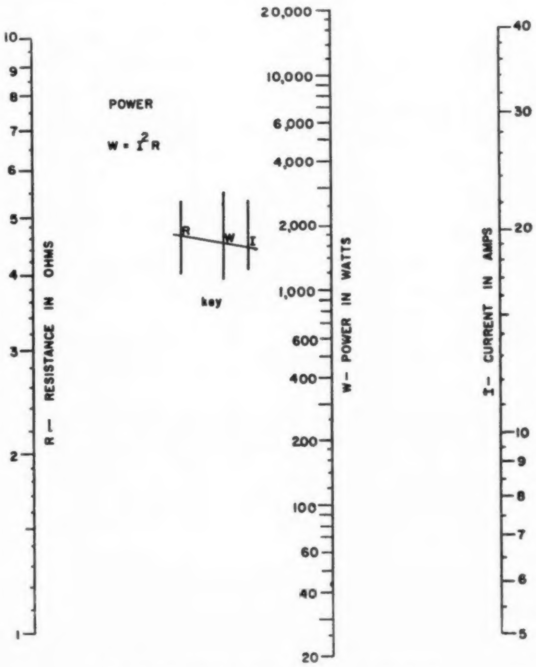

Fig. 2 Parallel scales with three variables

This paper was prepared expressly for AGRICULTURAL ENGINEERING and is authorized for publication as Journal Paper 1623 of the Michigan Agricultural Experiment Station.

The authors—JOHN R. DAVIS and CARL W. HALL—are, respectively, instructor and associate professor, agricultural engineering department, Michigan State College.

Acknowledgment: The authors express their appreciation to Dr. B. M. Stewart, professor of mathematics, Michigan State College, for reviewing the manuscript of this paper.

so involved that engineers cannot construct nomographs without a specialized course. Many advanced courses in agricultural engineering could include a few topics or illustrations of graphical presentations. Mathematics departments in educational institutions and in industry would provide the necessary cooperation.

SURVEY

To determine the availability of courses pertaining to graphical methods, the authors sent 55 letters in the fall of 1953 to mathematics departments in colleges of the United States and Canada which have agricultural engineering departments. Forty replies were received, and following is a summary of the information:

- Twenty-six schools do not offer courses in graphical methods in the mathematics, engineering, or other departments
- Ten schools offer courses in graphical methods in departments other than the mathematics department
- Four schools offer courses in graphical methods in the mathematics department
- Two schools offer an extension or correspondence course in which practicing engineers may study graphical methods.

From the results of the survey it is evident that many engineers do not have the opportunity to study graphical analysis in a formal class, under the guidance of a qualified college instructor.

GRAPHICAL METHODS

A few of the common alignment charts will be presented in this paper, to acquaint engineers not thoroughly familiar with this type of presentation. Textbooks may be consulted for the procedures involved in constructing nomographs and special charts; a list of selected textbooks is appended to this paper.

Conversion Charts

Practically every engineering activity provides an opportunity for the use of conversion charts, of which the following are: degrees Fahrenheit to degrees Centigrade; pounds to grams; moisture content, wet basis to dry basis; and, as shown in Fig. 1, gallons per minute to cubic feet per second.

Parallel Scales with Three Variables

The equation for this type of chart can be expressed in the form of equation [1].

$$f_1(x)+f_2(y)=f_3(z) \quad \ldots\ldots\ldots \quad [1]^*$$

$$x)^n=z \quad \ldots\ldots\ldots \quad [1a]$$

$$f(x)\cdot f(y)=f(z) \quad \ldots\ldots\ldots \quad [1b]$$

Exponential equations with three variables, with a constant power, such as equation [1a] can be expressed in the form of equation [1] by logarithms. Examples of equations suited to this form of alignment chart are: $Q=3.33\ BH^{2/3}$, an equation for weir discharge; $PV/T=4.44$, a thermodynamic equation; $D=RT$, an equation involving rate and time to determine distance. An example of a solution of equation [1] is shown in Fig. 2.

Parallel Scales with Four Variables

An equation of the form $f_1(x)+f_2(y)+f_3(z)$
$=f_4(t) \quad \ldots\ldots\ldots \quad [2]$

*f is a symbol that means "some function of."

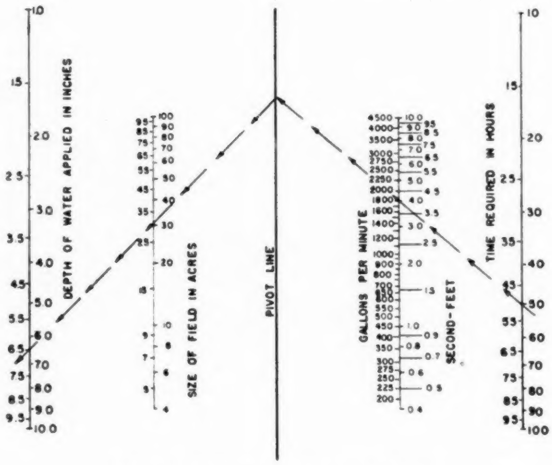

Fig. 3 Parallel scales with four variables

is presented easily by breaking the equation into two parts and treating each part as similar to equation [1]. This form of equation will involve the use of an index or pivot line to solve the problem. Equations involving products or exponents can also be reduced to the form of equation [2] by logarithms.

Equations such as $Q=(b/0.239)^{2.58}\ (b/L)^{0.5}$, a pipe discharge equation; $S=T/2\ (\pi r^2 t)$, the relation between shearing stress and twisting moment; and $E=NT/(NT+S)$, an

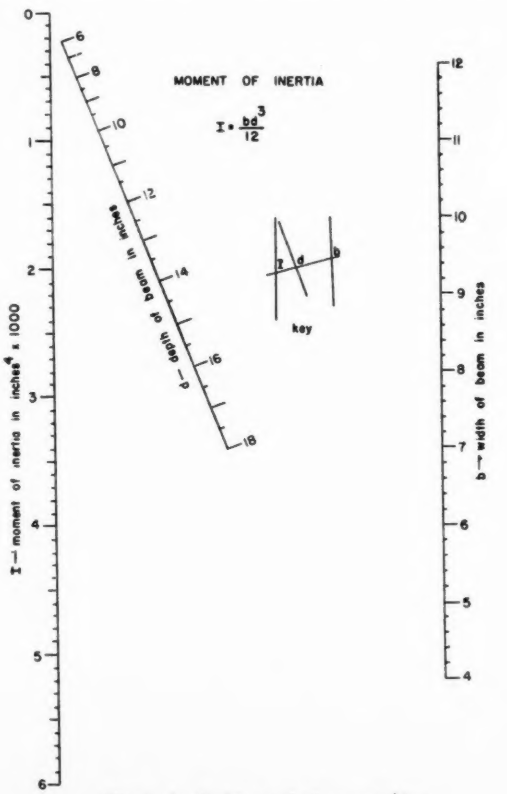

Fig. 4 An N chart with three variables

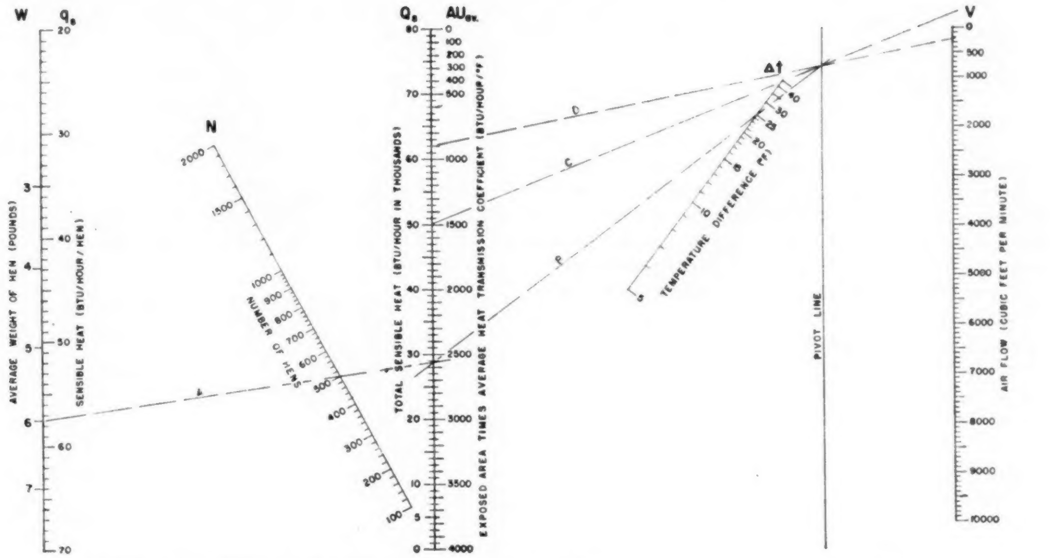

Fig. 5 A combination parallel scale and N chart (nomograph for determining winter ventilating rates)

equation for production efficiency, are examples suitable for this type of solution.

An example of this kind of nomograph was prepared by Garton **(3)**†, which typifies the simplicity and efficiency of graphic methods of presenting equations (Fig. 3).

N Chart with Three Variables

An alignment chart for multiplication or division using nonlogarithmic or natural scales can be constructed conveniently in the form of letters N or Z. The N chart is a variation of the proportional chart, which is an alignment chart for multiplication or division involving four variables. The equation that applies to this type of solution is

†Bold-faced numbers refer to the appended references.

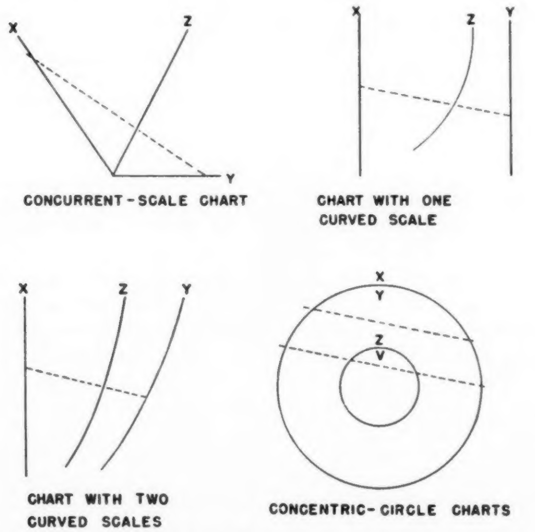

Fig. 6 Samples of alignment charts used in the solution of complex equations

$$f_1(x)/f_2(y)=f_3(z)/f_4(v) \quad . \quad . \quad . \quad . \quad . \quad . \quad [3]$$

which can be converted to the three-variable N chart form of

$$f_1(x)=f_3(z)/f_4(v) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [3a]$$

by making $f_2(y)$ equal to unity. A disadvantage of the N and proportional charts is that the range in values of the functions represented is from zero to the upper limit of the desired range, which may impair the accuracy of the readings. However, this may be of little consequence by omitting the part of the chart that is not needed. Examples of equations suitable for this type of solution are: $E=Wv^2/2g$, an energy equation; $S=(3.82\times T)/d^3$, a stress equation for ductile materials; and $COP=QA/W$, the equation for coefficient of performance; and $I=bd^3/12$, an equation for moment of inertia, shown in Fig. 4.

Combination Parallel Scale and N Chart

An equation of the form

$$f_1(x)+f_2(y)=f_3(z)/f_4(v) \quad . \quad . \quad . \quad . \quad . \quad [4]$$

can be presented by a combination of parallel scale and N charts. The following are equations adapted to this type of graphic presentation: $Q=A\times 0.5\times(T_1-T_2)$, a heat capacity equation; $W=2.67L\times(D^2-d^2)$, an equation for pipe weight, and $T_2/T_1=e^{\mu\theta}$, an equation for belt tension. A good example of a combination chart was prepared by Parker **(11)** to solve problems of ventilating rates for poultry houses (Fig. 5).

Alignment Charts for Solving Complex Equations

Other chart forms are employed for the solution of more complex equations, such as the following types: the concurrent scale chart for equations of the form $1/f_1(x)+1/f_2(y)=1/f_3(z)$; a chart with one curved scale for equations of the form $f_1(x)+f_2(y)\cdot f_3(z)=f_4(z)$; charts with two curved scales for equations of the form

$f_1(x)\cdot f_1(y)+f_1(z)\cdot f_2(y)-f_2(z)\cdot f_1(y)-f_1(x)\cdot f_1(z)=0$; and concentric circle charts for equations of the form

$f_1(x)+f_2(y)=f_3(z)+f_4(v)$ (Fig. 6). An equation can be adapted to one of these forms by use of logarithms or other mathematical adjustments.

Special Slide Rules

By moving functional scales along parallel lines the same general types of formulas can be solved as on the straight-scale alignment charts. The special slide rules with parallel moving scales require no index or pivot lines and are generally more convenient to use than an alignment chart. Frequently the special slide rule is more accurate than the ordinary slide rule, because an entire working range can be contained in the total length of the special slide rule, which is not done in the ordinary slide rule. For example, if the working range of temperatures involved in a certain process is from 200 to 220 F, the entire 20-deg range can be contained in the 8 or 10-in slide rule length, thus obtaining at least one more significant number. Often the ordinary slide rule is not as rapid as a special slide rule for the solution of a particular equation.

Blanks for the construction of special slide rules are available, but because of the limited demand are not too easily obtained. Satisfactory blanks can be made by gluing together several layers of cardboard and forming a tongue and groove for the slide by varying the width of the cardboard strips. Recently several manufacturers have printed special slide rules for the solution of specific problems and for advertising purposes. Generally these slide rules have utilized both sides and are used to solve a number of equations or conversions.

SUMMARY

Agricultural engineers have the opportunity to express themselves to a greater number of people than is the case in most other kinds of engineering or agricultural work. For this reason, the agricultural engineer should make use of all possible facilities or modes of expression to present his data and his profession admirably and clearly. Graphical methods of presentation provide a means of attaining this objective. Most graphical solutions are time saving and easily and accurately interpreted by both technical and non-technical persons.

The authors urge agricultural engineers to consider graphical methods of presentation of data in technical publications and papers and in the repeated solution of engineering problems. Students of agricultural engineering should be introduced to this method of presenting data in the undergraduate curriculum, and professional engineers should be given the opportunity to study these methods as a means toward greater efficiency of labor and skills.

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Nuclear Power

TO ESTABLISH a nuclear power industry in this country will be a great achievement. If power becomes cheaper and more plentiful, our material standard of living will be raised. In other countries the effect may be even greater. By the accident of history the first use of this great new discovery has been in the development of weapons of war, weapons of appalling magnitude. The nations of the world have today the means to destroy each other. They also have in this same nuclear energy a new resource which could be used to lift the heavy burdens of hunger and poverty that keep masses of men in bondage to ignorance and fear. Toward this peaceful development of nuclear power we have, all of us, a high obligation to work with all the ingenuity and purpose we possess.—Henry D. Smyth, in *Civil Engineering* for April, 1954.

Radiation Studies of Painted Shade Materials

T. E. Bond, C. F. Kelly and N. R. Ittner
Member ASAE Member ASAE

Search for Improved Methods of Relieving Hot Weather Distress of Farm Animals

ANIMAL environment is currently being studied cooperatively by the U.S. Department of Agriculture and the departments of agricultural engineering and animal husbandry of the University of California. One objective of the project is to improve methods of relief for animals distressed in hot weather.

An animal suffers from thermal stress when it produces more heat than it can easily dissipate. To adjust, it must reduce food consumption, and its production necessarily declines. Several relief media, such as cool drinking water **(1)***, sprays **(2)**, air-cooled shelters **(3)**, and different types of shades **(3)**, have been tested and found beneficial in varying degrees.

Probably the most economical means of helping an animal maintain a heat balance is to control incoming radiation. Radiation from the sun, sky, and surroundings adds greatly to the heat load, and is simply and substantially reduced with shades that cut off the direct solar energy load.

Since a shade does little to alter air temperature **(4, 5)**, humidity, or wind velocity (unless closed on one or more sides), its primary function is to shield the animal from the intense radiation of the sun. An animal under a flat shade, however, is still exposed to radiation from the sky, horizon, shadow, hot surrounding ground, and the shade material itself. This paper discusses the use of paint for altering the radiation characteristics of shade materials.

Shade Material as a Radiation Shield

An animal in the sun receives radiant energy from three sources: **(1)** sun and sky, **(2)** unshaded ground, and **(3)** "horizon," actually a band extending about 10 deg above the horizon. It is separated from the rest of the upper hemisphere in calculations because it radiates at a greater rate, as a result of back radiation from moisture in the heated air near the ground **(5)**. The quantities of radiant energy from these three sources on a typical August day at El Centro, Calif., are shown in Fig. 1.

The total radiant heat load on an animal in the sun, 244 Btu per hr ft^2 (of animal surface) was determined from black globe thermometer readings; the portions radiated by the hot ground and the horizon were determined with a Hardy radiometer **(5)**. These values are strictly true only for a small spherical object (whose shape factor is known with respect to the different parts of the surround), but the effects shown will approximate those for an animal.

The quantities and sources of radiant energy on an animal protected by shade are also shown in Fig. 1. Shade reduces radiant heat load from sun and sky, and substitutes shaded area for part of the hot ground, but it adds a new source of energy — the shade material itself. In this instance the total effect was nevertheless a reduction of the radiant heat load on the animal, from 244 to 167 Btu per hr ft^2 of animal surface. This is equivalent to reducing the mean radiant temperature† of the animal's surround from 153 to 98F.

Kelly **(5)** has shown how size, orientation, and height of shade affect the magnitude of the radiant heat load components: hot ground, shadow, sky, horizon, and shade, as shown in Fig. 1. This paper is concerned with the component from the shade itself, since only this part of the radiant heat load is affected by a change in the surface characteristics of shade materials.

The temperature that any surface may reach is highly dependent upon its surface radiation characteristics, although it should be emphasized that this temperature is

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Acknowledgment: The authors wish to express their appreciation for the guidance and council of Dr. F. A. Brooks of the University of California.

*Bold-faced numbers refer to the appended references.

†Mean radiant temperature: that temperature of a uniform enclosure (usually designated black, to eliminate reflection) with which a body would exchange the same amount of energy by radiation as in the actual environment.

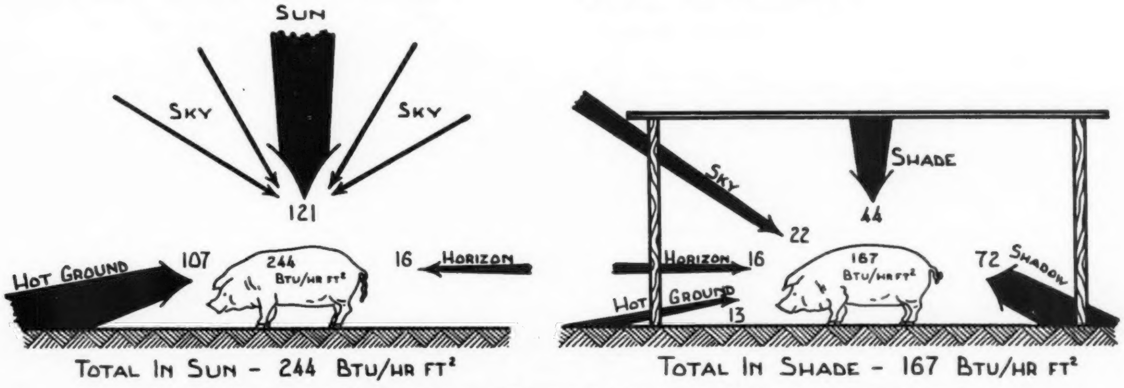

Fig. 1 Radiation received by animal in sun and animal in shade, on a typical August day at El Centro, Calif.

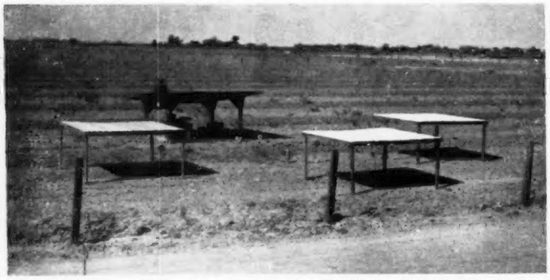

Fig. 2 Three 8 x 8 x 4-ft high test shades set up over a dirt field. Note black globe thermometers at center of each shadow and in sun

also a function of air temperature, wind velocity, and quantity and quality of incident radiant energy from sun, sky, and surrounding surfaces. Fishenden and Saunders **(6)** show that at sea level a black surface, backed by a non-conducting material and with normal exposure to the sun, could attain an equilibrium temperature of 233F. But such a high temperature is normally never reached, because of convection and conduction losses.

Certain materials, such as white paint, are highly reflective (low absorptivity‡) to short wave length radiation, and are very good emitters (high emissivity§) of long wave radiation at their normally low temperatures. White paint should provide a thermally desirable surface for the top of a shade, and it does, probably more nearly so than most other materials. In our study, white painted aluminum sheets were as much as 15F cooler than unpainted aluminum sheets when exposed to the sun. White painted galvanized iron sheets were as much as 50F cooler than unpainted ones.

While the characteristics of the top surface greatly influence the temperature of the shade material, it is the emissivity of the bottom surface that influences the quantity of energy, due to this temperature, that will be emitted to the animal. The reflectivity of the bottom surface determines the quantity of incident energy, from the ground, that will be reflected back down to the animal.

Since most of the energy radiated to the under side of the shade from the ground is long in wave length, like that emitted by the shade material, the emissivity and absorptivity of the bottom shade surface will be practically identical, according to Kirchoff's law. Should the bottom surface of a shade then have a low emissivity (smaller quantity of absorbed and emitted energy but greater amount of reflected energy), or should it have a high emissivity (larger quantity of absorbed and emitted energy and smaller amount of reflected energy)?

Method of Shade Comparison

To study the thermal effects of changes in radiation characteristics induced on the surfaces of various shade materials by painting, field tests of several materials were conducted during the summers of 1952 and 1953. Three flat, portable shade frames, 8x8x4 ft high, were covered with the materials tested. The frames were collapsible so that they could easily be moved (Fig. 2). One frame was always covered with plain corrugated embossed aluminum roofing, to serve as a check shade.

The real thermal comparison of two shades should be based on the relative comfort of animals under them. To obtain such a comparison, we used six-inch black globe thermometers under each shade. As suggested by Bedford and Warner **(7)**, these instruments can be used to determine the mean radiant temperature of the environment surrounding the globe. Globe thermometer readings can also be used to determine the total spherical irradiation at the globe (total radiation incident on the globe). The three shades were placed so that all environmental factors affecting them would be the same. A globe was maintained near the center of the shadow of each shade; one globe in the sun served as a base for comparison. The temperatures of all four globes were continuously recorded on a 16-point recording potentiometer.

The temperatures of the shade materials, obtained with thermocouples attached to the lower surfaces of the shades, were also continuously recorded. The quantity of radiant energy from the shade surface, and from different parts of the surround **(5)**, was measured with a Hardy radiometer.

RESULTS

The upper set of curves of Fig. 3 shows the radiant heat load on the globes under three shades covered with corrugated embossed aluminum roofing. The shade materials were identical except that two coats of Fuller's Myratec No. 1520 white paint were applied to the top surface of one, and two coats of Fuller's Myratec No. 1518 velvet black

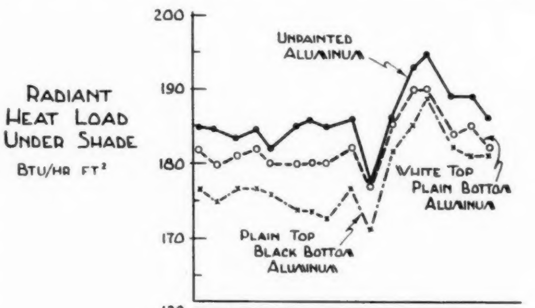

Fig. 3 Radiant heat load under each, and the surface temperatures, of three aluminum 8 x 8 x 4-ft shades over dirt—one shade unpainted, one white on top and plain underneath, the third plain on top and black underneath. Radiant heat load was determined from globe thermometer at the center of shadow

‡Absorptivity: the fraction of incident radiation absorbed by a substance. At any wave length and temperature the absorptivity of an opaque substance is equal to its emissivity or to one minus its reflectivity.

§Emissivity: the ratio of the intensity of radiation of any given wave length emitted from unit area of a surface to the intensity in the same wave length from unit area of a black body at the same temperature.

paint were applied to the bottom of another‖. The lower set of curves shows the surface temperatures of these three shades.

White paint and the unpainted aluminum sheet reflect about the same amount of solar energy (about 75 percent), but the emissivity of the white paint, at ordinary shade material temperatures, is much greater (about 0.89) than that of the unpainted aluminum (0.11 to 0.20). The white painted surface consequently maintained a lower temperature because of better radiation exchange with the cold sky. Since the radiation characteristics of the bottom surfaces were identical, the radiant heat load under the white painted shade was considerably less.

Although the temperature of the third shade, with the black painted underside, was about the same as that of the unpainted shade, the radiant heat load under it was as much as 12 Btu per hr less (per square foot of animal surface). Since the upper-surface radiation characteristics of these two were the same, the difference must be attributed to a reduction of reflected energy under the black painted shade. The undesirable effect (greater emission by the black surface) was less than the desirable effect (reduced reflection of incident energy). The black surface absorbed more radiation from the unshaded ground than did the unpainted surface, but at the same time it lost heat at a greater rate by radiation to the cool shadow. Furthermore, convection cooling would tend to prevent an excessive temperature rise of the black surface.

Although the black painted shade was usually about 8F hotter in surface temperature than the shade with the white painted top, the radiant heat load beneath it was lower by as much as 7 Btu per hr ft^2. This indicates that of the changes caused by the high absorptivity of the under surface the increased surface temperature was less important than the reduction in reflected energy.

For tests shown in Fig. 4, the desirable effects of the white top surface and the black under surface were combined in the shade that previously had only a black underside. The surface temperature of this shade then remained very close to that of the white-top shade, while the radiant heat load under it was as much as 13 Btu-per-hr ft^2 lower. This again shows the effect of reduction in reflected energy by a black under surface, and that this was more important than the accompanying increase in emission. The surface temperatures of these shades were at times 15F lower than that of the unpainted aluminum shade. The radiant heat load under the white and black shade was as much as 18 Btu per hr ft^2 (of animal surface) lower than under the unpainted shade.

A shade material that has invariably proved "cooler" than most others is hay. One of the shades was covered with a 4-in layer of hay and results compared with the unpainted and the white and black aluminum shades. The curves for this test are shown in Fig. 5. The radiant heat load under the hay shade was much lower than that under the other two shades. Here the hay temperature (bottom surface) remained very close to that of the air, and as much as 25F lower than the surface temperature of the plain

‖The possible beneficial effects of black paint were originally suggested by J. R. McCalmont, agricultural engineering research branch, U.S. Department of Agriculture.

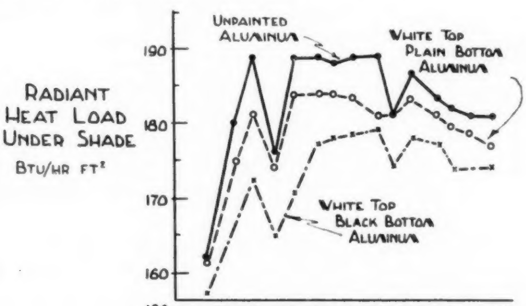

Fig. 4 Radiant heat load under each, and the surface temperatures, of three aluminum 8 x 8 x 4-ft shades over dirt—one shade unpainted, one white on top and plain underneath, the third white on top and black underneath. Radiant heat load was determined from globe thermometer at center of shadow

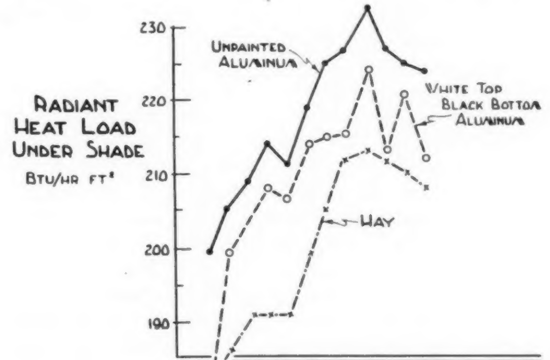

Fig. 5 Radiant heat load under each, and the surface temperatures, of three 8 x 8 x 4-ft flat shades—two covered with corrugated embossed aluminum (one painted white on top and black underneath), and the third shade covered with a 4-in layer of hay. Hay temperature was measured at bottom surface. Radiant heat load was determined from globe thermometer at center of shadow

aluminum shade. The very uneven character of the hay surface evidently acts as a black surface and absorbs most of the irradiation on it from the hot ground, thereby reducing the energy reflected back down to the animal. We do not know what the surface convection coefficient for the hay is, but, because of the uneven character of the surface, it is probably very high. The hay presumably lost much of its heat to the air by convection. Also, because of the insulating value of the 4-in layer of hay, the bottom surface did not receive much heat from the top surface by conduction. Although hay has excellent thermal properties, it does have limitations as a shade material for it must be replaced periodically and does not provide a permanent and weatherproof structure when such is desired.

Painted galvanized iron roofing sheets were compared in a manner similar to the comparison of aluminum sheets described above, and the same beneficial effects of paints were noted. White paint applied to the top surface of galvanized iron caused a reduction of as much as 50F in its temperature, bringing it within a few degrees of the temperature of white painted aluminum sheets. The addition of white paint to the galvanized iron sheet made it a "cooler" shade material than plain aluminum, establishing a lower radiant heat load beneath it.

DISCUSSION

It has been previously mentioned, and should be emphasized again, that the differences in radiant heat load and surface temperatures among the different shades shown in the curves above will not always be of the same magnitudes. These differences may be lesser or greater, depending upon many environmental factors affecting the shades, such as wind velocity, air temperature, radiation from the sun and sky, and ground cover.

Ground cover alone can greatly affect the heat load on an animal, because of the differences in temperature and reflectivity of different types of ground surfaces. In testing two identical portable aluminum shades at El Centro, Calif., in 1951, it was found that the radiant heat load on an animal under shade over green pasture was 14 Btu per hr ft^2 less than under shade over dirt. In other words, the mean radiant temperature of the environment was about 12F less.

Painted and unpainted aluminum shades were then compared in a green pasture field. The differences in radiant heat load and shade surface temperatures effected by the white painted top surface and the black painted under surface were very evident but to a lesser degree than indicated in the above curves for the same shades over dirt. While the reflectivity of the green grass cover was higher than that of the dirt field, its surface temperature was much lower and consequently its emitted energy was less. The character of the under surfaces of shades was less important over a grass surface, the radiation from it being less. The characteristics of white upper surfaces, however, would be equally important with shades over grass or dirt.

What has been said of painted surfaces for flat shades would be true for other roof shapes if the bottom surface is exposed to radiation from hot surrounding ground surfaces. The white painted surface would still be beneficial, even if the shade had walls that intercepted radiation from the hot ground. However, in the case of an enclosed shade or building, the under side of the roof should be painted with aluminum paint to promote the most comfortable conditions in summer (4).

A heat balance on the shades (not included here), and an analysis of the factors involved, bears out the interpretations of the data and shows several significant points: (1) The lower the temperature of the shade material, the greater will be the benefits from the black paint. Any lowering of the shade temperature will add greater weight to the reduction in reflected ground energy by the black paint. The shade temperature can be lowered by increased wind velocity (greater convection cooling), white painted top surface, evaporatively cooled surface (water or sprays on roof), and double or insulated roofs. (2) The greater the radiation from the ground and lower hemisphere, the greater will be the benefit from black paint. As the radiation from the ground becomes greater so does the importance of reducing the energy reflected by the shade back to the animal. Consequently, black paint is more beneficial applied to shades over dirt than to shades over grass. (3) The higher the shade the greater will be the benefit from the black paint. As the height of shade increases it "sees" more of the hot ground (in comparison to the shadow) and the importance of the black paint in reducing reflected energy becomes greater. For the same reason the benefits from black paint, for a particular shade height, will be less as the shade size becomes larger. The shade "sees" proportionately less of the hot ground as its size increases.

SUMMARY

The primary purpose of a shade is to protect an animal under it from intense radiation from the sun and sky. An animal under a flat shade, however, is still exposed to radiation from the sky, horizon, shadow, hot surrounding ground, and from the shade material itself. The radiation from the latter source can be minimized by applying white paint to the top surface and black paint to the under surface. It was shown that under the environmental conditions of our tests the undesirable effects of increased surface temperature and emission, due to the high absorptivity and emissivity of the black under surface, were less important than the reduction in reflected energy from the hot ground caused by this black surface.

The combined desirable effects of white painted top surface and black painted under surface were shown to help greatly in reducing the radiant heat load on an animal under a flat shade of aluminum or of galvanized iron, and should aid in increasing an animal's comfort, and consequently its production, in a hot climate.

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Grain Drying with Unheated Air

Effect of Building, Duct, and Fan Arrangements on Drying Performance

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Member ASAE

EARLY in 1952 two grain-drying buildings were erected for tests at the Iowa State College agricultural engineering farm at Ames. They were furnished by the Great Lakes Steel Corporation and were identical in construction, having similar duct and fan installations. They were for studying the effect of various arrangements on performance in drying. Each has been loaded four times with oats or corn to be dried immediately after harvest.

The bins are of galvanized steel and have concrete floors. The general appearance is shown in Fig. 1. Each is 16 ft wide by 20 ft long. The central longitudinal duct has a cross section of about 4½ sq ft and a perimeter of about 6 ft. The sidewalls and the end walls, except at the doorway, are lined inside and outside with corrugated sheets. The inner lining at the doorway is on a removable panel so that the building may be used for other purposes by removing the panel.

As first erected, the central duct, assembled from 8-ft lengths, extended from the back of the building to within about 4 ft from the front end. The inner wall lining extended up from the floor a distance of 8 ft on the sidewalls and about 6 ft high on the end walls. The lining sheets overlapped 2 in and fitted fairly tightly together at the seams except at the sidewall seams between the first and second sheets from the floor. These seams were held open about ½ in by spacers on the bolts to permit exhaust or entry of air while the fan was operating. The grain was put in through a hatch just to one side of the ridge.

A fan was installed in each bin at the back end of the duct. The fans were operated by 3-hp direct-connected electric motors and were identical except that in one building the air was exhausted from the duct, while in the other the air was forced into the duct. The fans were calibrated at the factory of the Aerovent Fan Company so that by taking readings of pressure the volume of air moved could be estimated.

One loading of oats and one loading of corn were dried in the buildings as originally erected. As a result of experience during the drying, they were modified after the first season. The height of the end-wall linings was increased so that the grain could be loaded as deep at the ends as at the center of the building. An additional section of duct was provided to extend to the front end of the building. All seams in the sidewall lining were opened as one on each side had been before and for one test some of the openings at the seams were enlarged. Screen wire was applied above the top sheet of the inner lining to prevent grain from spilling over the sheets. The above changes were made to improve the performance in drying. At the same time another change was made to facilitate testing. This was to erect a plywood bulkhead about four feet from the door end of each building. This reduced the grain capacity and was done only to permit more accurate measurements of air movement. This change obviously would not be suggested except for test purposes.

The tests included measurement of temperature, grain moisture, air pressure in the mass of grain, air volume supplied by the fan, and atmospheric conditions. The test equipment will not be described here but the usual equipment was supplemented by special facilities for determining air-pressure gradients and paths of air flow. Also humidity elements for measuring moisture content without withdrawing samples or otherwise disturbing the grain were furnished by Minneapolis-Honeywell Regulator Company for the 1953 corn tests.

Two tests were made in each building as originally erected, one with oats and one with corn. Following is a brief description and discussion of each:

Test I. Oats, July, 1952

The oats were harvested July 10 to 12, part being combined direct and part after windrowing. Each day's harvest was collected in another bin, then transferred to the test bins in order to distribute the moisture as evenly as possible. It was planned to use oats with a moisture about 22 percent but it was much drier when loaded. The grain moisture content in each bin averaged 16.3 percent, the samples varying from 14.6 to 18.0 percent. Fifteen hundred bushels were placed in each bin. The fans were operated simultaneously in both bins. The bins were emptied on August 20 and 21 at which time about 40 samples from each bin showed a range of moisture from 10.6 to 12.3 percent. A few moisture samples were taken during the test. These showed that drying was slowest in the regions at the front end of the building to each side of the center. The grain was only about 5 ft deep in this area, but the last 4 ft of grain had no centerline duct. The original moisture being only 16.3 percent, any difference there may have been in drying effectiveness between the suction and pressure bins could not be detected in the final moisture or quality of the oats.

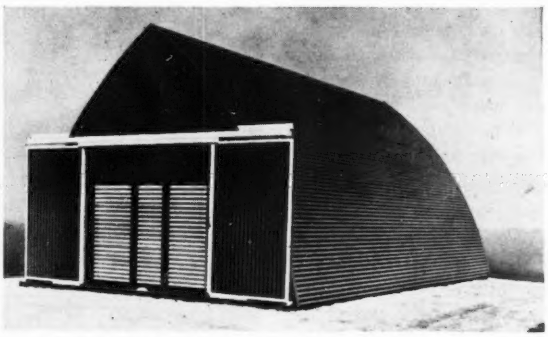
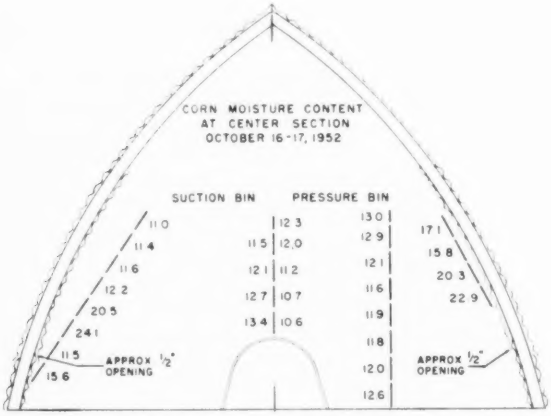


Fig. 1 Grain bin of the type used in tests on the Iowa State College agricultural engineering farm

This paper was prepared expressly for AGRICULTURAL ENGINEERING. It reports the results of research work carried on cooperatively by the U.S. Department of Agriculture and the Iowa Agricultural Experiment Station, and has been approved as Journal Paper No. J-2490 of the Iowa Agricultural Experiment Station, Project No. 587.

The author — W. V. HUKILL — is principal agricultural engineer in charge of grain storage investigation, farm buildings section, agricultural engineering research branch, U.S. Department of Agriculture.



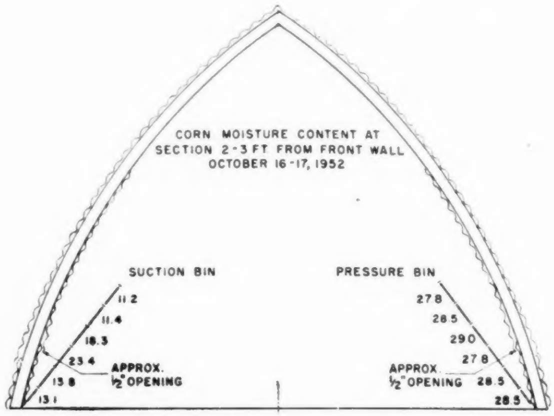


Fig. 2 *(Left)* Cross section at center of bin showing corn moisture content of samples taken October 16 and 17, 1952 • Fig. 3 *(Right)* Cross section near the door end of the building showing corn moisture content of samples taken October 16 and 17, 1952

Test 2. Corn, September-October, 1952

Both bins were filled with shelled corn on September 26, the corn having been harvested with a mechanical picker during the previous four days. It was held as ear corn in a separate crib and all shelled on the date indicated. The average moisture of the shelled corn was 31.2 percent. Figured at 56 lb to the bushel, 1487 bu were put in the suction bin and 1515 bu in the pressure bin. The fans were started September 26 at 6:20 p.m., and except for a few interruptions were operated continuously until November 4 at 1:20 p.m. The fans were operated again for 5 hr on November 20 and 8 hr on November 28. By the middle of October most of the corn had been reduced to below 13.5 percent, but there were locations in each bin where the moisture content was higher. Fig. 2 is a cross section of the bins at midlength on which the corn moisture content on October 16 and 17 at various points is shown for both the pressure and suction bins.

Fig. 3 is a similar cross section two feet from the front end of the building. The grain depth is shallower at the front end and the ventilating duct does not extend through this section. It will be seen that there are some points in both bins where the moisture was still high on October 16 and ventilation had to be continued to dry the corn at such points. With continuous ventilation until November 4 and two short periods thereafter the corn was left in the bins until late in January. When the bins were unloaded, most of the corn was in good condition. There was some mold damage in all samples but this was largely due to the severe mechanical damage that occurred during shelling. All the corn in the pressure bin was dry and suitable for feeding. In the suction bin there were some areas where the corn was caked and molded so badly it was discarded. About 63 bu, or 4 percent, was in this condition.

Fig. 4 shows some of the spoiled corn left in the bin at unloading. It was in a region on the north side of the duct starting at the duct and extending out and upward toward the sidewall. This caking was in the front two-thirds of the building only and did not appear on the other side of the duct. There was also a caked spot beyond the end of the duct and toward the front corner of the building in the south half (the half north of the duct is shown in the figure). The wooden framework appearing in Fig. 4 is a support for the tubes used for measuring static pressure of air in the grain. This framework was abandoned in later tests.

As a result of these two tests the buildings were modified as previously described. Tests with oats and corn were again made in 1953.

In the oat test one side of each building retained the single ½-in opening in the sidewall, while in the other side the seams between all four sheets were opened up to about ½ in and the crack between the bottom sheet and the floor was held open about the same distance.

Test 3. Oats, July, 1953

In the 1953 oat test the initial moisture was again lower than desired, averaging 15.75 percent in the suction building and 17.25 in the pressure building. The oats dried satisfactorily in both sides of both buildings. Analysis of the air flow from pressure readings showed a better distribution in the side where there were more openings, but because of the low initial moisture this was not reflected in differences in the condition of the oats.

Test 4. Corn, October, 1953

The bins were changed in only one respect for this test. One sidewall in each building had all the seams open about ½ in and the other wall had all seams open about 1½ in. The corn for this test was harvested with a picker-sheller and loaded directly into the bins from the field. Harvesting

Fig. 4 Spoiled corn remaining in suction bin after unloading the original 1952 test corn

took most of a week so the moisture was not as evenly distributed as in the previous corn test. Corn moisture content at loading averaged 24.35 percent in the pressure bin and 23.65 in the suction bin. For this test humidity elements for use as corn moisture indicators were available and were buried in the corn at 55 locations in the two bins. Loading was completed on October 3 and the fans were operated most of the time until October 18. On October 21, 25 samples were taken from each bin. Most samples had from 10 to 13 percent moisture, the highest in the suction bin having 15.7 percent and the highest in the pressure bin, 12.8 percent. In each case the air circulation was better distributed at the side of the bin having larger openings. The bins were emptied February 19 and all the corn in both bins was in good condition.

The effectiveness of ventilation at various locations in each bin is illustrated in Figs. 5 and 6 which show the number of hours of fan operation until the corn moisture content at each location reached a relative humidity level of 80 percent, approximately 16 percent corn moisture. This was measured by the humidity elements that were imbedded in the corn at the locations indicated by dots in Figs. 5 and 6. This level (80 percent) is chosen arbitrarily for showing the drying time, but at each location the moisture dropped to 13 percent within a few hours of the time it reached the 80 percent level. The location of the humidity elements is not identical in the two bins because the earlier tests had indicated that slow-drying locations would be found near the sidewalls in the pressure bin and from one foot to 3 or 4 ft above the floor in the main bulk of grain in the suction bin.

The areas where the grain dried most slowly (Figs. 5 and 6) were apparently related to the particular paths taken by the ventilating air in exhausting from or entering from the sidewall openings. Points of relatively poorly ventilated grain show up as, for example, the fourth point from the floor in the suction bin, Fig. 5. This point was apparently in a streak of slow-drying grain similar to that in the 1952 corn test where molding and spoilage occurred. In looking at Figs. 5 and 6 it should be kept in mind that the positions shown by the dots are where the moisture elements were first installed. The corn shrunk during drying and the actual position of each element was shifted downward as drying progressed.

CONCLUSIONS

The following conclusions can be drawn from the tests and observations:

Extending the duct the full length of the building and sealing the lining joints at both end walls eliminates certain problem regions found in tests 1 and 2.

Changing to higher end walls which permit the grain to be loaded to the same level from end to end of the building contributes to more uniform drying.

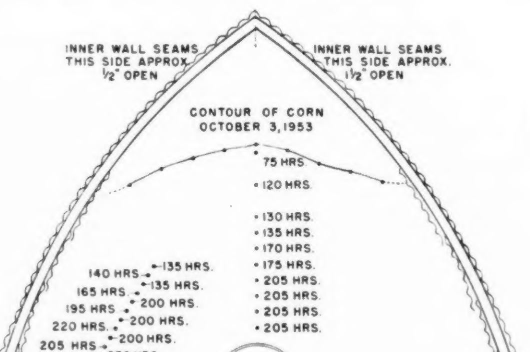
While each successive step in getting more opening at the sidewalls has improved the effectiveness of drying, further tests will be needed to determine how far it is economical to go toward a completely open sidewall, such as screen wire as compared with spaced openings. When air enters or leaves the grain through two or more openings separated by a space without openings, streaks of slower drying grain are the result. It is not known how near together the openings need to be to avoid trouble from such streaks, but they were observed with a spacing of 2 ft between openings.

In comparing suction with pressure operation there are three apparent differences that influence the choice of direction of air flow.

1 From the practical view, it is advantageous to have the wettest grain where it can be most readily inspected. Since drying occurs first where the air enters the grain, the top surface of the grain in the suction bin becomes dry quickly, inviting the operator to believe that all the grain is drier than it actually is. On the other hand, in the pressure bin drying starts near the duct and the top surface grain remains damp for a longer period.

2 The resistance to air flow is greatest near the duct because of high velocities in that area. In the pressure bin this grain dries first and shrinkage loosens the bulk in this area soon after drying is started. This results in a net decrease in air resistance. In the suction bin the grain in this region does not dry and shrink so soon. As a result, with a given fan substantially more air is supplied to the

(Continued on page 405)



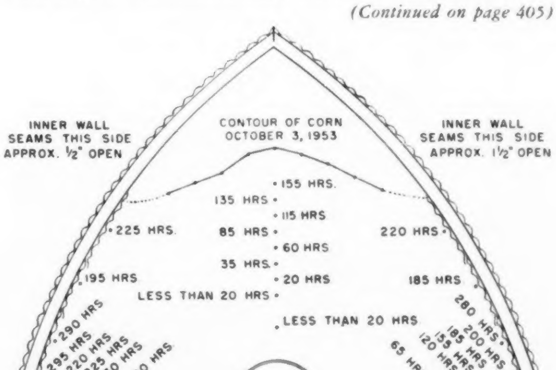


Fig. 5 *(Left)* Cross section of suction bin showing the number of hours of fan operation required to reduce the relative humidity at the various locations to 80 percent • Fig. 6 *(Right)* Cross section of pressure bin showing the number of hours of fan operation required to reduce the relative humidity at the various locations to 80 percent

Water Table Drawdown Characteristics

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INVESTIGATIONS on depth and spacing of lateral tile drains have taken mainly the form of comparing the drawdown characteristics of the water table between tile drains installed at various depths and spacings. In making these studies, investigators have utilized various sized observation wells and open auger holes. More recently groups of piezometers have been used to study ground water and water-table movements. Controversy has often arisen over the relative ability of large and small-diameter observation holes, cased and uncased, to reflect the position of the receding water table in the finer textured soils. Walker (**3**)* reported that a statistical analysis of variance of data collected on 1-in and 10-in wells and ⅜-in piezometers in the lighter soils in Virginia revealed no significant difference. There were, however, indications that differences may occur in wells in heavier soils. The purpose of this paper is to report on a comparative study of four field methods of water-table observation in Brookston clay loam soil near Elsie, Mich. An evaluation and discussion of a new depth and spacing formula proposed by Walker (**4**) is also presented.

MATERIAL AND PROCEDURE

The four methods compared in the spring of 1953 were 2-in-diam auger holes, ⅜-in-diam perforated wells, 2-in-diam perforated wells, and groups of six ⅜-in-diam piezometers (Fig. 1). Observation devices for each method were installed in a row parallel to a tile drain (Fig. 2). The spacing between the observation devices was 3 ft. The rows were placed at varying intervals of 2 to 20 ft symmetrically on each side of the drain. The elevations of the bottoms of each observation device including the deepest piezometer were the same as the bottom of the drain. The bottom of the other five piezometers were placed at 6 and 3-in vertical increments above the drain elevation. Ground-level elevations at each row were also determined. Eight nylon resistance blocks were installed in one row at 6 and 3-in vertical increments to ascertain their ability to indicate the extent of the saturated zone within the soil profile. To prevent compaction of the soil while making water table observations, two portable planks to walk upon were placed on top of cement blocks. Water table measurements were made with an electric waterlevel indicator to the nearest hundredth of a foot.

Resistance readings of the nylon blocks were taken with a Bouyoucos bridge, and, by means of a potentiometer and thermocouples beside the blocks, temperature readings were made to determine the temperature corrections to be applied to the resistance readings. A standard non-recording rain gage was installed adjacent to the study site to record the rainfall prior to and during the periods of measurement. After obtaining the last water table drawdown measure-

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Acknowledgment: The authors express their appreciation to Drs. A. E. Erickson and E. P. Whiteside, soil science department, Michigan State College, for assistance with the soil analyses. They are indebted also to Roscoe Smith, George Moore, Robert Moore and to members of the agricultural engineering department staff of Michigan State College for aid and constructive criticism during the conduct of the study.

*Bold-faced numbers refer to the appended references.

Fig. 1 An installation for the comparison of four methods of water-table measurement. Left to right, 2-in auger hole (indicated by square wooden cover), ⅜-in perforated well, 2-in perforated well, and group of six ⅜-in piezometers

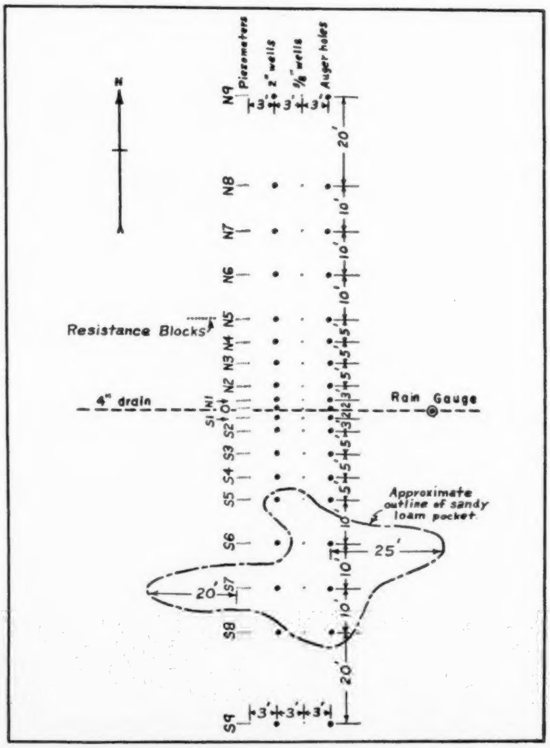

Fig. 2 Plan view of the site used for a study of four field methods of water table observation

ments, undisturbed soil core samples 3 in in diameter and 3 in long were taken from each soil horizon in each row. The core sampler and sampling technique were similar to those described by Uhland and O'Neal (2). The percent by volume of pore space drained at a tension of 60 cm permeability, and volume weight determinations were made on each sample.

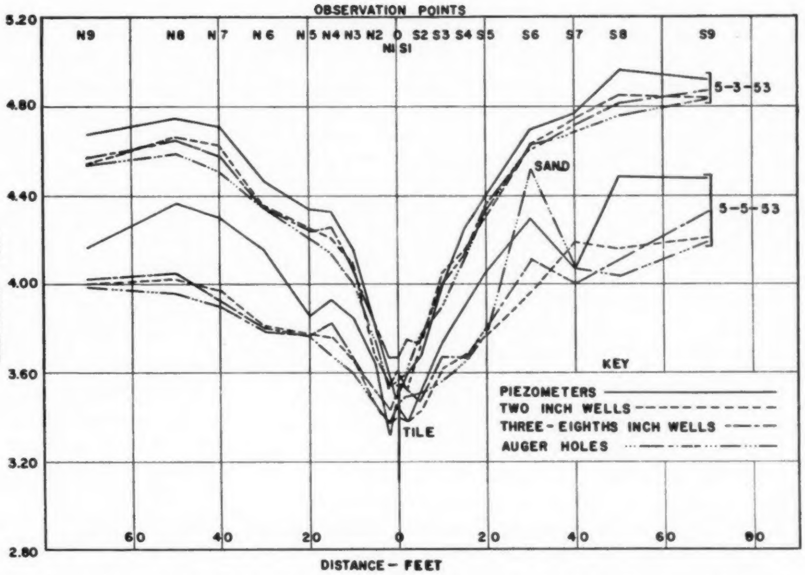

Fig. 3 Comparison of water table drawdowns for the four methods of measurement used

RESULTS AND DISCUSSION

Two sets of daily water table drawdown observations were obtained between the periods April 27 to April 30, and May 3 to May 6, 1953. At the time the observation devices were being installed, a sandy loam pocket was encountered near the south end of the study site (Fig. 2). The extent of the pocket was determined by means of a soil auger but the pocket was not contiguous to any tile drain. Therefore, there was no extraneous effect on the drawdown curves for any of the methods. However, the auger holes failed to stand up in the sandy loam pocket. This showed the inadequacy of this method in coarser textured soils.

A statistical analysis of variance to evaluate differences between the water table data obtained by the four methods is shown in Table 1. The data compared in the analysis were checked to eliminate any source of error in measurement due to mud or sand in the bottom of the observation devices. The highest water-level elevation observed from the group of six piezometers was considered to be a measure of the water table reflected by the piezometer method.

TABLE 1. ANALYSIS OF VARIANCE OF WATER TABLE MEASUREMENT DATA

Source of variation	Degrees of freedom	Sum of squares	Mean square
Locations	9	12.29	1.36**
Days	2	3.29	1.65**
Methods	3	0.63	0.21**
Locations x methods	27	0.36	0.013**
Locations x days	18	0.51	0.028**
Methods x days	6	0.07	0.012**
Locations x methods x days*	54	0.36	0.0024

Mean of methods				Necessary differences	
Piezometers	2-in wells	3/8-in wells	Auger holes	p = 0.05	p = 0.01
4.075	3.924	3.956	3.881	0.025	0.034

* Best error term.
** Significant at the 1 percent level.

The necessary differences between the means for significance at the 1 percent and 5 percent probability levels are 0.034 and 0.025 ft, respectively. A recheck on the datum elevations used to determine the water-level elevations disclosed an occasional maximum variation of 0.01 ft. For practical purposes this amount of error could be expected. Because of this known possible variation and lack of replication, the necessary difference was based at the one percent level.

A comparison of the four means indicates that size relationship, which in this study was 16 to 1, was not necessarily the cause of significant differences. The water-level observations from the piezometer method show the greatest lag. It also appears that observations from cased wells lag those from uncased holes, and there are indications that observations from small cased wells lag those from large cased wells. However, more replicates of a similar study in still finer textured soils are necessary for more conclusive results.

A graph of the drawdown curves on May 3 and May 5 for each method is shown in Fig. 3 to illustrate the order of magnitude of the discrepancies observed between methods. From a practical point of view the lag in the piezometer

TABLE 2. COMPARISON OF WATER TABLE ELEVATIONS OBSERVED BY THE FOUR METHODS TO THE ELEVATION OF THE SHALLOWEST SATURATED RESISTANCE BLOCK

Observation method	Elevations, ft May 3	May 4	May 5	May 6
Piezometer	4.34	4.27	3.86	3.69
Two-inch well	4.26	3.94	3.77	3.63
Three-eighths-inch well	4.25	3.94	3.77	3.65
Auger hole	4.20	3.89	3.77	3.81*
Resistance block	4.38	4.38	4.12	3.87
Maximum differences	0.18	0.49	0.35	0.24

* Mud level.

method is quite significant, becoming most apparent toward the end of the drawdown period. It is, however, doubtful whether the small differences between the other three methods are of any practical importance since it has not been established by scientific investigation to such a precise degree as these small differences, the recession rate of the water table required for adequate drainage.

Only the general movement of the upper limit of the zone of saturation was obtained by means of the nylon resistance blocks. Laboratory calibration of resistance at saturation was not too closely related in some cases to what appeared to be the saturated resistance of the blocks in the field.

However, it was assumed that a state of saturation existed if any field readings at any elevation remained fairly constant from day to day. Table 2 shows that for any day between May 3 and May 6, the blocks indicated that the soil was saturated to a higher elevation than the water table as indicated by any of the four methods. On May 4 a maximum difference of 0.49 ft was observed. This discrepancy is believed to be caused by a combination of disturbed soil surrounding the blocks causing reduced permeability, presence of a zone of capillary saturation immediately above the water table, and the failure of open-hole types of observation devices to reflect accurately the position of the water table. The significant differences found between methods seem to indicate that inaccuracies though small do exist.

It appears that under these conditions the piezometer method is the most reliable of the four methods. Although there is no certainty that this method measures accurately the position of the water table, it does follow the upper limit of the zone of saturation as measured by the blocks, more closely than the other three methods. In the final analysis, a measure of the recession rate of this upper limit for adequate drainage should be the criterion sought.

It was desirable to carry this study further by utilizing the soil test data obtained from the study site to evaluate under Michigan conditions a new depth and spacing formula proposed by Walker **(4)**. The regular use of the formula is to assume two different drain depths and solve for the drain spacing at each depth. A comparison of the two solutions will indicate the most economical design. However, the evaluation procedure for this study was to use the depth of the installed drains at the site, solve for the drain spacing, and compare this computed spacing with the actual field spacing.

The formula consists of two parametric equations

$$\text{Cos } \theta = \Delta yp/2\,Kt$$
$$\text{and } S = 2 \text{ conj } y \tan \theta$$

The computation for determining the spacing is as follows:

Depth of drain from ground surface	2.0 ft
Recession increment per day, Δy	0.7 ft
Porosity × unit volume, p	0.087
Time interval, t	1.0 day
Minimum permeability, K	1.50 fpd
$\text{Cos } \theta = \Delta yp/2\,Kt$	0.0203
$\text{Tan } \theta$	49.38
Average depth to drain, conj y	0.65 ft
Spacing, $S = 2$ conj $y \tan \theta$	64.2 ft

The computed spacing is 64.2 ft whereas the field spacing is 110 ft. The owner of the property has observed the drainage of the field since the time that the drains were installed some 40 years ago. His opinion was that the drains were spaced too far apart because during an occasional prolonged wet spring, the drainage has not been adequate.

Since the minimum recession rate in the formula was obtained from the investigational work of Neal **(1)**, his observations were evaluated. He observed that crops were not seriously injured, if, in essence, the water table was held at least 6 in below the surface, and receded to a depth of 18 in below the surface in 29 hr. Using the drawdown curves obtained from the comparative study, it was found that a drain spacing of 20 ft would be required to meet these conditions. Thus it seems quite evident that more specific knowledge of the minimum recession rate of the water table for adequate drainage is needed at this time in order to know first what criterion should be used for depth and spacing design. Walker's **(4)** formula did, however, give a spacing in close agreement with recommendations by experienced drainage engineers.

SUMMARY

Four field methods of measuring the water-table drawdown characteristics were compared to determine whether there were any differences in observational data. Two-inch auger holes, ⅜-in perforated wells, 2-in perforated wells, and groups of six ⅜-in piezometers were installed in parallel rows to a tile drain at varying intervals symmetrically on each side of the drain. One set of nylon resistance blocks was installed in an attempt to evaluate the methods further.

A statistical analysis of variance revealed significant differences between data from all methods except between data from the 2-in and ⅜-in well methods. With the qualification that more replicates are necessary, it was concluded that observations from cased wells lagged those from uncased wells, observations from small cased wells lagged those from large cased wells, and, under these study conditions, the piezometer method was more reliable based on results obtained from the resistance blocks.

A newly reported depth and spacing design formula was evaluated under Michigan conditions. The formula gave results in accord with recommendations of experienced drainage engineers. It is quite evident that more specific information on the minimum recession rate for adequate drainage is needed.

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Contemporary British and European Tractors

Wayne H. Worthington
Fellow ASAE

(Continued from the March, April and May issues)

An interesting series of air-cooled diesel engines is used to power the farm tractors built by the world's oldest manufacturer of internal-combustion engines, Klockner-Humbolt-Deutz of Cologne. Their output includes five wheel tractors ranging in size from 11 to 60 hp and one 60-hp track-type tractor. Brief specifications of the wheel tractors are given in Table 10.

Hydraulic power lift with a two-cylinder double rockshaft and three-point implement attaching linkage is available for the 15 and 30 hp models. No automatic control of draft or working depth is provided.

DEUTZ air-cooled diesel engines used in the four large tractors are described in detail in this author's paper, entitled "Contemporary European Air Cooled Diesel Engines," SAE Transactions, vol. 61, 1953, and will not be discussed here. The single-cylinder engine used in the smallest tractor was placed in production in 1952, and differs from the others in having the cooling-air fan cast integral with the flywheel, in the use of cast fins surrounding the cylinder barrel, and in the use of an auxiliary rotating balance weight which permit higher rotating and piston speeds.

The Hannover Machine Works of Hannover manufacturers HANOMAG motor trucks, track-type and wheel tractors. One two-cycle and three four-cycle basic diesel engines are built as follows:

3.34-in bore x 3.54-in stroke	(air cooled 1–2-cycle)
One cylinder	12-hp wheel tractor
3.54-in bore x 4.33-in stroke with precombustion chamber	
Two-cylinder at 1600 rpm	16-hp wheel tractor
Two-cylinder at 1950 rpm	19-hp wheel tractor
Three-cylinder at 1500 rpm	22-hp wheel tractor
Three-cylinder at 1900 rpm	27-hp wheel tractor
Four-cylinder at 1500 rpm	28-hp wheel tractor
Four-cylinder at 1900 rpm	35-hp wheel tractor
Four-cylinder at 2800 rpm max	50-hp 1½-ton and 2-ton truck
4.33-in bore x 5.90-in stroke with open combustion chamber	
Four-cylinder at 1200 rpm	45-hp wheel tractor
Four-cylinder at 1300 rpm	55-hp wheel tractor
4.53-in bore x 5.90-in stroke with open combustion chamber	
Six-cylinder at1300 rpm	90-hp track-type tractor

The author – WAYNE H. WORTHINGTON – is director of engineering research, John Deere Waterloo Tractor Works of Deere Manufacturing Co.

TABLE 10. DEUTZ WHEEL TRACTORS

Rated belt horsepower	11	15	30	42	60
Engine — no. of cylinders	1	1	2	3	4
Bore and stroke, in	3.54 x 4.72	4.33 x 5.51	4.33 x 5.51	4.33 x 5.51	4.33 x 5.51
Engine speed, rpm	2100	1650	1650	1650	1650
Piston speed, fpm	1652	1515	1515	1515	1515
Starter	Electric 12-v	Electric 12-v	Electric 12-v	Electric 12-v	Electric 12-v
Speeds, mph (min. tires)					
Forward					
First	1.06	1.93	2.18	2.49	2.36
Second	2.05	2.68	2.92	3.23	3.30
Third	3.36	3.73	3.61	4.23	4.22
Fourth	3.11	7.46	7.46	7.02	7.46
Fifth	6.21	12.42	12.42	12.42	12.42
Sixth	9.94	—	—	—	—
Reverse					
First	1.06	1.93	2.80	1.99	1.86
Second	2.05	—	—	—	—
Third	3.36	—	—	—	—
Power shaft					
Size	1⅜, 6 spline	1⅜, 6 spline	1⅜, 6 spline	1⅜ 6 spline	1¾, 6 spline*
Speed, rpm at rated engine speed	560 and 1650	594	575	—	540
Mower drive, rpm	1100	—	—	—	—
Tires, regular					
Front	4.00 x 16	5.00 x 16	5.50 x 16 6.00 x 20	6.00 x 20 6.50 x 16	6.50 x 20
Rear	8-24 7-30 7-36	8-32 10-28	10-28 11-28 9-42	13-30 14.00 x 20	13-30 15-30
Wheelbase, in	70.9	62.3	68.5	81.5	95.6
Tread, in (regular)					
Maximum	59.0	59.0	59.0	55.1	60.7
Minimum	49.2	49.2	49.2	—	—
Special, min	—	34.6	—	—	—
Drawbar height, in					
For implements	11.8 to 16.5	12.8	16.1	16.9	14.6
For trailer	—	18.1	20.8 to 31.5	26.8 to 27.6	31.5
Turning radius, min					
Without steering brakes	10 ft 10 in	—	—	9 ft 10 in	16 ft 5 in
With steering brakes	9 ft	9 ft 2 in	8 ft 6 in	—	13 ft 2 in
Operating weight, lb	1825	2825	3805	5160	6380
Weight per bhp, lb	166	188	127	123	106

*Special equipment.

The large number of ratings are confusing and difficult to understand, but our information is that domestic needs for wheel tractors are largely taken care of with the 12, 19, and 35-hp models. Specifications of these are given in Table 11. Unfortunately, no photographs are available of any of these tractors.

Available extra equipment includes hydraulic-power lift with centrally mounted rockshaft for the operation of implements mounted at the front, middle, and rear; three-point implement attachment linkage without automatic draft and depth control; side-mounted mower drive; wheel weights, auxiliary skeleton wheels, spring pintle hook, belt pulley, fenders with seat, cab, and creeper transmission. Hanomag has cooperated with a number of independent implement manufacturers to develop equipment which may be offered their dealers.

The use of one, two, three, and four-cylinder engines has introduced a number of compromises in weight per horsepower and weight distribution. In their new 12-hp tractor, they appear to have gone far toward the objective of producing a light-weight tractor with good weight distribution.

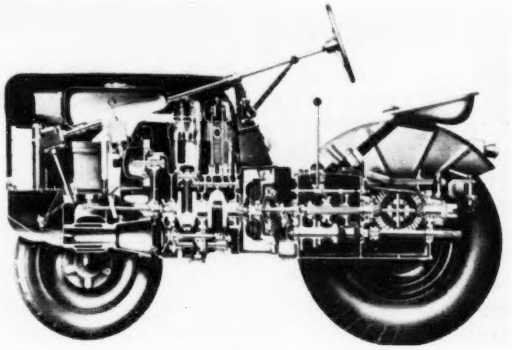


Fig. 49 Cross section of two-cylinder model of Allgaier air-cooled tractor

The ALLGAIER Works of Uhingen is located in the Black Forest area of Western Germany. This firm manufactures tractors with single, two, three, and four-cylinder air-cooled four-cycle diesel engines, all with a bore and stroke of 3.73 and 4.53 in, respectively. They are rated at 11 bhp per cylinder at 1850 rpm and piston speed of 1400 fpm. The air-cooling system is built under license from Dr. Porsche, designer of many famous German sports and

TABLE 11 HANOMAG WHEEL TRACTORS

Model	R 12	R 16	R 19	R 27	R 35
Rated horsepower	12	16	19	27	35
Belt horsepower, max	—	15.5	18	25.5	33.5
Engine bore and stroke, in	3.34 x 3.54	3.54 x 4.33	3.54 x 4.33	3.54 x 4.33	3.54 x 4.33
Type	2 cycle	4 cycle	4 cycle	4 cycle	4 cycle
No. of cylinders	1	2	2	3	4
Speed, rpm	—	1600	1950	1900	1900
Piston speed, fpm	—	1152	1410	1370	1370
Starting	12-v	12-v	12-v	12-v	12-v
Tire sizes (regular)					
Front	4.00 x 16	4.50 x 16	4.50 x 16	5.50 x 16	6.00 x 20
Rear	7-30	7-36	8-32	8-36	9-42
Tread, in	49.2	49.2	49.2	49.2	49.2
	54.1	54.1	54.1	55.1	55.1
	58.3	59.1	59.1	61.0	61.0
Wheelbase, in	70.8	63.0	63.0	67.0	70.8
Ground clearance					
Under front axle	16.35	—	—	—	—
Under rear axle	16.75	—	—	—	—
Travel speeds, mph					
Forward					
First	0.92	2.30	2.36	2.30	2.30
Second	1.68	2.98	3.05	3.05	3.11
Third	2.86	3.98	4.11	3.86	3.91
Fourth	3.58	7.21	7.41	6.96	7.21
Fifth	6.73	11.88	11.58	11.06	11.38
Sixth	11.68				
Creeper speeds*					
First	0.37	0.53	0.48	0.53	0.53
Second	0.68	0.68	0.62	0.72	0.72
Third	1.18	0.93	0.83	0.90	0.90
Operating weight, lb	1760	2575	2575	3345	4095
Weight per bhp	147	166	143	131	122
Weight distribution, lb					
Front	—	1035	1035	1145	1320
Rear	—	1540	1540	2200	2775
Weight on front wheels, percent	—	40.2	40.2	34.3	32.3
Turning radius, ft					
Without steering brakes	—	10 ft 6 in	10 ft 6 in	11 ft 1 in	12 ft 6 in
With steering brakes	—	8 ft 3 in	8 ft 3 in	8 ft 6 in	10 ft 2 in
Power shaft					
Size, in	1⅜, 6 spline	1⅜, 6 spline	1⅜, 6 spline	1⅜, 6 spline	1⅜, 6 spline
Speed, rpm	575	553	572	553	553

*Available as special equipment.

TABLE 12. ALLGAIER AIR-COOLED TRACTOR SPECIFICATIONS

Model	A 111	A 122	A 133	A 144
Rated horsepower	11	22	33	44
No. of cylinders	1	2	3	4
Engine speed, rpm	—	2000	1900	2000
Piston speed, fpm	—	1518	1442	1518
Starting	12 volt	12 volt	12 volt	12 volt
Tires sizes, regular				
Front	4.00 x 15	5.50 x 16	5.50 x 16	6.00 x 20
Rear	7-24	10-28	10-28	13-30
Wheel tread, in	39.3 min	49.2	49.2	—
	62.9 max	54.3	54.3	55.2 to 65.0
	—	59.6	59.6	—
	—	64.9	64.9	—
Wheelbase, in	66.9	59.2	64.9	75.75
Travel speeds, mph				
First	1.9	1.47	1.6	2.59
Second	3.1	2.33	2.5	4.14
Third	5.0	3.34	3.6	6.07
Fourth	9.5	5.76	6.2	8.90
Fifth	—	11.51	12.4	14.50
Reverse	0.99	1.47	1.6	1.99
	1.60	—	—	—
	2.40	—	—	—
	4.70	—	—	—
Creeper	—	—	—	1.34
Weight, lb	1655	2975	3180	4340
Weight per rated bhp, lb	150	135	96.3	98.6
Power shaft				
Front-size, in	—	1⅜, 6 spline	1⅜, 6 spline	1⅜, 6 spline
Speed, rpm	—	1000	950	1000
Rear, rear-axle driven	No	Yes	Yes	No
Rear, transmission driven				
Size, in	1⅜, 6 spline	1⅜, 6 spline	1⅜, 6 spline	1⅜, 6 spline
Speed*	550	584	554	584

*Speeds at engine rpm shown.

racing cars. A swirl combustion chamber is used. A cross section of the two-cylinder model is shown in Fig. 49. A number of interesting features are shown including the barrel-type crankcase with individual cylinders, the centrifugal cooling air blower, and fluid coupling in the flywheel. An auxiliary power take-off, driven through a spiral bevel pinion from the differential bevel drive gear, gives a speed proportional to travel speed. Also shown are the forward location of fuel tank and front ballast weights, front and rear power-take-off shaft and hydraulic implement lift with automatic draft and depth control. The single-cylinder tractor is shown in operation in Fig. 50. Brief specifications of their latest tractors are given in Table 12.

Three-point implement attachment linkage is available with a hydraulic control having automatic draft and depth control. Special equipment includes a side-mounted mower drive and a number of optional tire sizes not listed. The large number of unusual features incorporated in these tractors evidences a great measure of ingenuity.

Fig. 50 Single-cylinder model of Allgaier air-cooled tractor in operation

The Neuss Works of the International Harvester Company manufactures tractors with three and four-cylinder diesel engines using a maximum number of common interchangeable parts, with a precombustion chamber similar to that used on the American-built tractor. A two-cylinder tractor, as yet unannounced, is in development. These German-built tractors were designed at the Neuss Works and are built to meet continental requirements and conditions. Specifications have so far been made available only for the four-cylinder engine, which are briefly summarized in Table 13.

The point of special interest regarding these engines is their successful operation on the diesel cycle with a bore diameter of only 3.15 inches.

One factor which has made possible the manufacture of tractors by so many small manufacturers is the availability of complete transmissions and auxiliary equipment. The latter includes drop axles with final drives, transmission-driven rear power take-offs, front or side-mounted power take-offs for mower drive, steering and parking brakes, friction clutches, belt pulleys with drives, front axles, and steering gears. By using combinations of "standard" parts, it is possible to meet a wide variety of power and working conditions. There are four such manufacturers in Western Germany, the most prominent being the Friedrichshaven Gear

TABLE 13. MODEL DF GERMAN-BUILT IHC TRACTOR GENERAL SPECIFICATIONS

Rated belt horsepower	25
Number of cylinders	4
Bore and stroke, in	3.15 x 4.00
Compression ratio	19:1
Speed, rpm	1650
Starter	12-v with glow plug
Power shaft	
Size, in	1⅜, 6 spline
Speed, rpm	550
Travel speeds, mph	
First	2.34
Second	3.08
Third	3.97
Fourth	9.42
Reverse	3.26
Tires (regular)	
Front	5.00 x 16
Rear	9-42
Wheelbase, in	78.3
Turning radius, in, min, with steering brakes	10 ft 8 in
Weight, lb	3850
Weight per bhp, lb	154

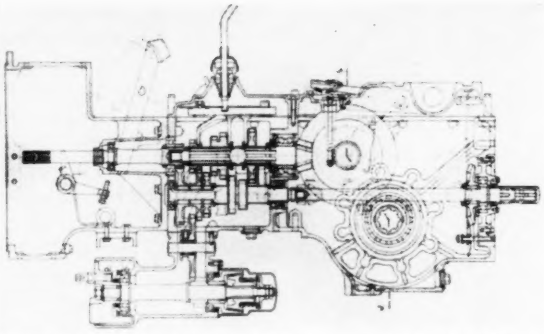


Fig. 51 Longitudinal section of ZF transmission (Friedrichshaven Gear Works)

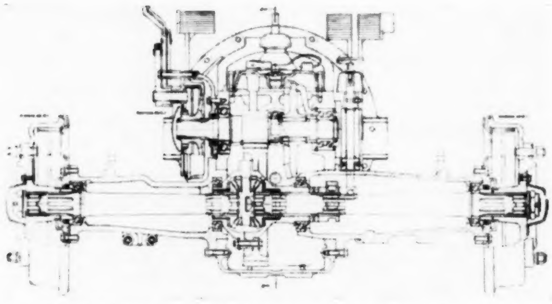


Fig. 52 Differential and final drive, straight-through axles of ZF transmission (Friedrichshaven Gear Works)

Works and its licensee, the Passau Gear Works. The Augsburg Gear Works, manufacturers of the RENK transmission, has a French licensee to supply domestic French tractor builders. Sections of ZF transmission units, built by Friedrichshaven Gear Works are shown in Figs. 51, 52, and 53.

In general, gears are made of casehardening alloy steel. One steel commonly used contains approximately 1.5 percent of both nickel and chromium. Induction hardening is not used with either carburized or full-hardening gears. Extensive use is made of the "spread center" or "variable center" practice in cutting spur gears. When spur gears are cut on Maag generators, 20-deg basic rack cutters are used, or when cut on Fellows-type machines, 20-deg circular cutters are used. Gears generated by either method operate at pressure angles up to 26 deg. The final finishing on the working faces is obtained by either shaving previous to hardening or by grinding with generating or formed wheels after hardening. Many gear plants in Western Germany used American-built Gleason spiral bevel-gear generators, which produce gears generally similar to those made in this country. More generally used are "Eloid" spiral bevel and hypoid gears, with teeth cut on Oerlikon spiral bevel-gear generators. These machines are built by the Oerlikon Machine Tool Works of Zürich-Oerlikon, Switzerland. Eloid gearing has teeth with a constant height over the face, in which the elements of the root and face cones are parallel. Data regarding contact conditions or beam strength has not been made available.

Many manufacturers in limited production have incorporated features which evidence great ingenuity and consideration for meeting special requirements. One such is that built by the Andreas STIHL Machine Tool Works of Waiblingen. This tractor is equipped with a single-cylinder air-cooled two-cycle diesel engine with bore and stroke of 3.54 x 4.72 in, respectively. This engine was described in the paper entitled "Contemporary European Air Cooled Diesel Engines" (SAE Transactions, vol. 61, 1953). Fig. 54 shows a general view of the tractor as tested at Marburg. The tractor delivers 12.4 bhp maximum at 1914 engine rpm, with a specific fuel consumption of 0.473 lb per bhp-hr. Minimum specific fuel consumption at 85 percent maximum output was 0.460 lb per bhp-hr. A steel tubular member forms the tractor frame and connects the transmission with the clutch housing. The tractor has a wheelbase of 55.1 in, treads front and rear of 50.5 in and 58.8 in, a minimum turning radius, using steering brakes, of 9 ft 6 in. Four forward speeds of 1.70, 3.2, 4.56, and 8.64 mph are provided with a reverse of 1.70 mph. Operating weight without

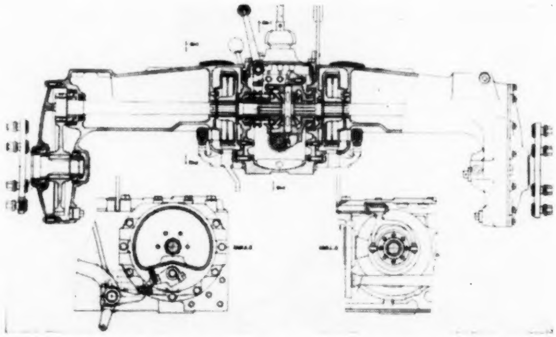


Fig. 53 Differential and final drive with drop housings of ZF rear axle (Friedrichshaven Gear Works)

operator is 1590 lb with 755 lb, or 47.5 percent, supported on the front wheels.

Joseph BAUTZ of Saulgau, Württemberg, is a long-time manufacturer of hay tools and grain binders, and more recently of three models of tractors. These are powered with engines built by the Mannheim Machine Works and are rated at 14, 17, and 24 bhp at 1800 rpm. The bores are hard-chrome plated for long life. The tractors have a wheelbase of 68 in, minimum turning radius of 98½ in and weights of 2135, 2950, and 3080 lb, respectively, or 152, 174, and 128 lb per bhp. A discrepancy of this nature is hard to understand. Unfortunately no photographs are available for reproduction.

Xavier FENDT and Co. of Markt Oberdorf, Bavaria, built five models of tractors using engines manufactured by the Mannheim Machine Works with ZF transmissions sup-

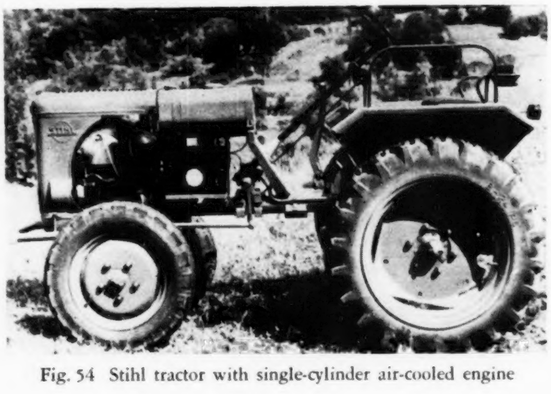


Fig. 54 Stihl tractor with single-cylinder air-cooled engine

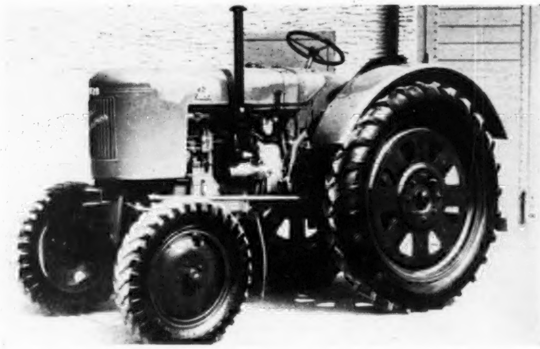


Fig. 55 Fendt "Dieselross" tractor with two-cylinder-engine

plied by the Friedrichshaven Gear Works. Specifications of the two tractors tested at Marburg are shown in Table 8. Fig. 55 shows the two-cylinder Model F 28. The cylinder bores of the MWM engines are porous chrome plated to better withstand sulfur erosion. The eight travel speeds, ranging from 1.55 to 12.42 mph, show the versatility which this manufacturer builds into his tractor to meet small farm needs.

The FAHR Machine Works of Gottmadingen manufactures a number of heavier farm machines such as field choppers and combines, including one of two German-built self-propelled combines. They also manufacture tractors using engines supplied by other manufacturers with transmissions built by their subsidiary, the Passau Gear Works. Four wheel tractors are built in seven sizes as follows:

Model	D 12	D 17	D 22	D 25	D 30	D 45	D 60
Rated belt hp	12	17	22	25	30	45	60
Weight, lb	2425	2932	3200	4300	4344	5324	6615
Weight per bhp, lb	203	173	145	172	145	118	110

The three-point implement attaching linkage with hydraulic-power lift is available as special equipment but without automatic draft and depth control. Fahr offers their dealers a wide variety of implements for attaching to the three-point tractor linkage. Most of these are manufactured by independent implement builders.

The Fahr Machine Works also builds an interesting one-axle (garden tractor type) tractor, powered with a 10-hr, four-cycle, two-cylinder-opposed engine for which a two-wheel riding cart is available. This little tractor is mounted on 7-18 pneumatic tires with treads adjustable to 26, 34, 42,

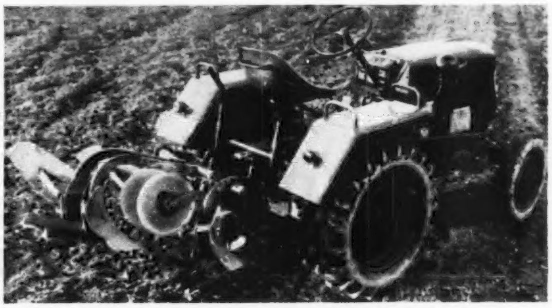


Fig. 56 Guldner 17-hp tractor with single-cylinder engine

and 50-in widths. Four forward speeds of 1.6, 2.8, 4.7, and 9.3 mph are available. The differential has an individual wheel lock. Several thousand single-axle tractors of this general type are manufactured each year in Western Germany.

The GULDNER Motor Works of Aschaffenburg is a long-established manufacturer of internal-combustion engines. At present, they build three models of tractors rated at 17, 22, and 35 engine horsepower, respectively. The smallest of the engines is shown in Fig. 56. The two smaller tractors have been officially tested at Marburg and the specifications listed in Table 8. Little information is available regarding the 35 hp tractor other than that it is provided with a five-speed transmission with speeds from 0.90 to 12.75 mph and has a shipping weight of 4115 lb.

The HOLDER Machine Works of Grunbach has manufactured single-axle and four-wheel tractors, optionally available with either gasoline or diesel two-cycle air-cooled engines rated at 9.5 bhp at 2000 rpm. More recently they introduced a four-wheel tractor of equivalent power, with a two-cycle diesel engine, and weighing 1340 lb. Tread widths of 29.5, 39.4, and 45.3 in are available. These small tractors are intended for use in truck garden and small farms.

KRAMER Brothers Machine Works of Gutmadingen manufactures tractors rated at 12, 17, 22, 33, and 45 bhp. These are variously powered with one, two, and three-cylinder air and water-cooled engines. A six-speed trans-

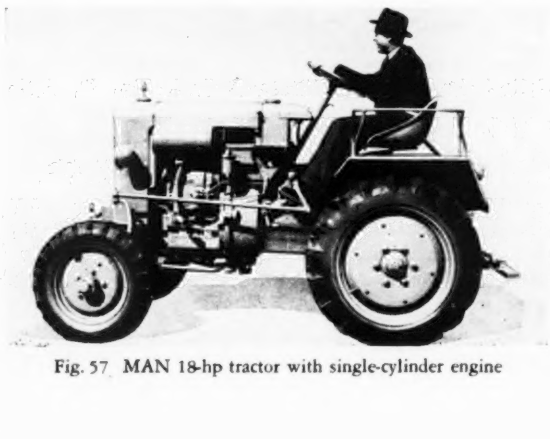


Fig. 57 MAN 18-hp tractor with single-cylinder engine

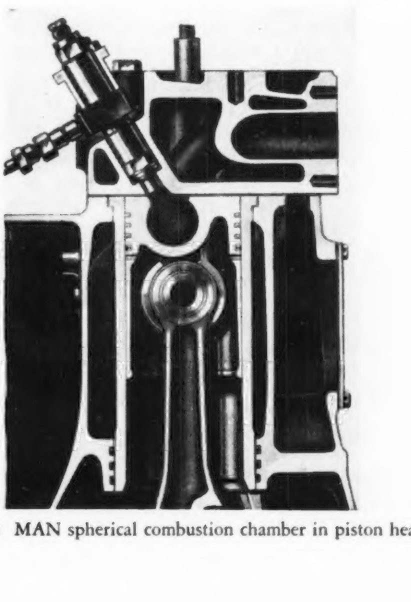


Fig. 58 MAN spherical combustion chamber in piston head

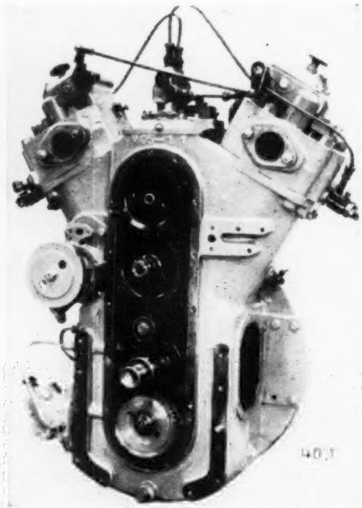


Fig. 59 Front view of Orenstein-Koppel and Lubecken V engine showing auxiliary-drive gear train

mission is used on the two smaller tractors with five speeds provided for the three larger sizes. As these tractors have not been officially tested, their performance cannot be reported.

The MAN Works of Nürnberg, the world's oldest manufacturer of diesel engines, manufactures four-wheel farm tractors of 18, 25, 30, and 42 hp. The former, shown in Fig. 57, is powered with a single-cylinder engine. The others are built with two-wheel and four-wheel drives and are all powered with four-cylinder engines. These engines all feature the MAN spherical combustion chamber formed in the piston as shown in Fig. 58. A removable cast cover completely encloses the injection pump and drive. None of these tractors have been tested at Marburg, but at Ultuna, Sweden, the two and four-wheel-drive tractors rated at 25 bhp developed a maximum output of 24.85 bhp with a specific fuel consumption of 0.401 lb per bhp-hr. It was found that at normal travel speeds of 3.67 and 5.22 mph, the drawbar pull of the four-wheel-drive tractor was slightly lower than that of the two-wheel drive, because of less wheel slippage and consequently higher travel speed. The over-all efficiency of the four-wheel-drive unit was 3 percent higher in the 3.67 mph travel speed and the same at 5.22 mph as compared with the two-wheel drive. The belt horsepower measured at the dynamometer as at Nebraska was 92 percent of the engine power, evidencing abnormally high transmission losses.

The ORENSTEIN-KOPPEL and Lübecken Machine Works of Dortmund-Dorstfeld manufacture tractors of 18, 36, 40, 50, 75, and 100 hp. The engines and transmissions used in these tractors are as follows:

Rated belt horsepower	18	36	40	50	75	100
No. of cylinders	1	2	2	2	4	4
Bore, in	4.54	4.54	4.72	4.72	4.54	4.72
Stroke, in	6.3	6.3	6.3	6.3	6.3	6.3
No. forward transm. speeds	5	5	5	5	6	6*

*Special high speed optionally available.

All two and four-cylinder engines are of the V type as shown in Figs. 59 and 60. Transmissions are manufactured by the Fredrichshaven Gear Works. The 36 and 50 hp tractors have been officially tested at Marburg. The results of the belt tests are as follows:

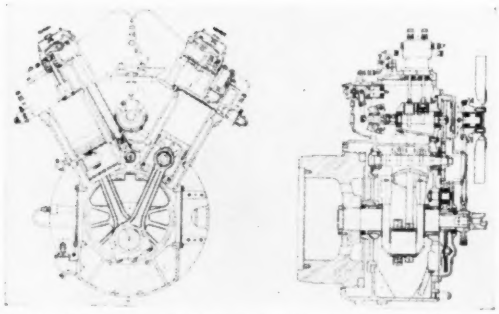


Fig. 60 Longitudinal and lateral sections of Orenstein-Koppel and Lubecken V engine

Fig. 61 Orenstein-Koppel and Lubecken 18-hp tractor with single-cylinder engine

Fig. 62 Orenstein-Koppel and Lubecken 100-hp tractor with four-cylinder V engine

Rated horsepower	36	50
Maximum corrected belt horsepower	35.7	42.6
Specific fuel consumption at max belt horsepower, lb per hp-hr	0.529	0.559
Operating weight without ballast and operator, lb		
Front wheels	1980	—
Rear wheels	2595	—
Total	4575	—
Percent of total weight on front wheels	43.2	—

The information regarding the 50-hp tractor is from an unpublished and incomplete Marburg report. No three-point implement attachment or hydraulic controls are available. The 18-hp tractor is shown in Fig. 61 and the 100-hp tractor in Fig. 62.

Karl RITSCHER, Inc., of Sproetze, manufacture four-wheel tractors rated at 12, 20, 28, and 40 hp. The 12 and

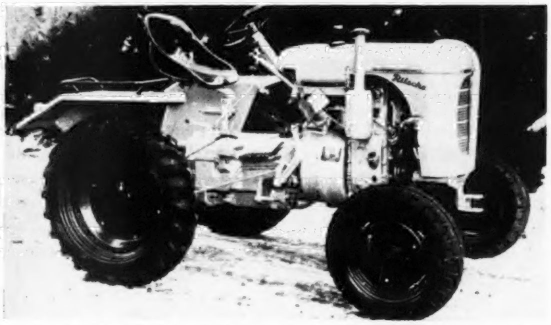


Fig. 63 Karl Ritscher 12-hp tractor with single-cylinder engine

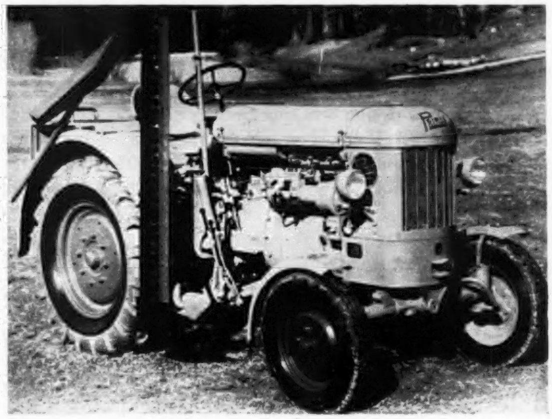


Fig. 64 Primus Model 30/36 tractor with three-cylinder engine


Fig. 65 Ruhrstahl implement carrier

20-hp models are powered with single-cylinder engines, the 28-hp model with a two-cylinder engine, and the 40-hp model with a four-cylinder engine. All engines are manufactured by the Mannheim Machine Works (MWM).

The side elevation of the single-cylinder tractor is shown in Fig. 63. The tractors have not been tested at Marburg and available data regarding their construction is inadequate for detailed consideration.

The ROHR Machine Works of Landshut, Bavaria, build four basic models rated at 15, 20, 28, and 40-bhp. All are powered with MWM diesel engines. The first two have one-cylinder engines, the 28-hp model has a two-cylinder engine, and the 40-hp model a three-cylinder engine. The tractors appear to be assembled with a "standard" transmission. No official test data is available and the information received from the manufacturer is inadequate.

The PRIMUS Tractor Company of Miesbach, Upper Bavaria, build tractors rated at 12, 17, 20/24, and 30/36 hp. These are powered with one, two, and three-cylinder diesel engines. The 30/36-hp model is shown in Fig. 64. These tractors have not been officially tested and the manufacturer's information is insufficient for study and evaluation.

In an effort to provide an "implement carrier" which can use existing animal-drawn implements, the RUHRSTAHL Works, Witten-Anne, have developed and officially tested the tractor shown in Fig. 65. This unit is powered with a two-cylinder diesel engine which developed 19.55 hp at the belt, with a specific fuel consumption of 0.556 lb per bhp-hr. Four forward and four reverse speeds of 1.96, 3.28, 5.38, and 10.20 mph are provided. This manufacturer's literature makes a good case for power farming but contains little information regarding what implements can be used with this tractor and how they may be mounted.

The engineering of the components, such as engines and transmissions, used in contemporary German wheel tractors is of a superior order and reflects great engineering skill. However, that part of tractor design requiring a complete knowledge of farm operations and crop practices appears to be considerably less developed. The small manufacturers are handicapped by a lack of engineering facilities and their limited production cannot support research and development on the scale necessary to a quick solution of the many problems involved. The larger manufacturers are handicapped by a self-imposed competitive situation that involves far more types and sizes than can be justified by the requirements. Efforts to use the greatest number of interchangeable parts have in many cases defeated the design objectives to be met by the smaller tractors if they are to capture the market for which they are built.

In conclusion, it appears that although full mechanization of the farms in Western Germany offers many unsolved problems, enormous strides have been made by the few experienced tractor and implement builders and that future efforts may be expected to follow the lines of development rather than invention.

Grain Drying with Unheated Air

(Continued from page 395)

pressure bin than to the suction bin during a large part of the drying period.

3 Air moving through a fan becomes heated as a result of the energy required to drive the fan. In the pressure bin this heat is applied to the air before it enters the grain, increasing its drying power. In the suction bin the heat is applied to the air after it has left the grain and therefore it not usable for drying. Under the conditions of these tests the temperature rise due to this cause was about 3F. While this is not a large temperature difference, it is enough to increase the rate of drying substantially.

Weather conditions during both seasons of corn drying were unusually favorable. Corn and oats can be dried successfully with this type of building. The operation would be more economical from a power viewpoint if the air were more uniformly distributed.

With the plywood bulkhead, these bins have given an excellent opportunity to determine the nature of flow paths. The humidity elements have proven very useful in detecting grain-moisture gradients.

Equipment for Heat-Treating Garbage for Hog Feed

Paul James

IN JULY, 1952, a contagious swine disease known as vesicular exanthema began to sweep through the country. In 45 days it traveled through 18 states. By the end of the first year it had left a trail of lame and sick pigs in almost every state.

There was no question but that the disease was rapidly getting out of control. Matters were made worse because this disease of swine was difficult to tell from the most dreaded of animal diseases—the foot and mouth disease. No chances could be taken with the tremendous capital investment of this nation's swine. Veterinarians of state and federal governments agreed the disease was carried chiefly by raw garbage fed to pigs. Meetings were held with state and federal regulatory officials and representatives of the swine industry, and all agreed that in order to eradicate the disease one important step would be to prohibit the feeding of raw garbage to swine. It was realized that over a million swine a year are produced by feeding raw garbage to them, and in order to utilize this valuable by-product, some way had to be found to make the garbage safe so that it could be fed without spreading disease.

The majority of the states passed laws permitting the feeding of garbage if it was boiled one-half hour to kill any disease virus present in it. The questions then began to flood both state and federal agricultural departments. How do we cook twelve tons of garbage at a time? What is the most economical setup for cooking one barrel at a time? What about pressure cooking? Can we cook in our collection trucks? From the nature of these and many other questions it was quite evident there was need for a calm and orderly approach to the problem from a scientific engineering viewpoint.

In handling this urgent problem, the USDA engineer assigned to it first visited numerous installations in the neighborhood of Washington, D.C., in order to observe both good and poor designs. On these visits temperatures were measured throughout a load of garbage with thermocouples fastened to a copper rod at 6 in intervals. After measuring the temperatures, suggestions were made on how to improve the equipment. One nearby Virginia farmer needed help badly. He relocated steam injection pipes in his truck according to our recommendation. This worked so well he immediately piped another truck similar to it. It was then decided to visit all the best installations in the country to accumulate valuable information.

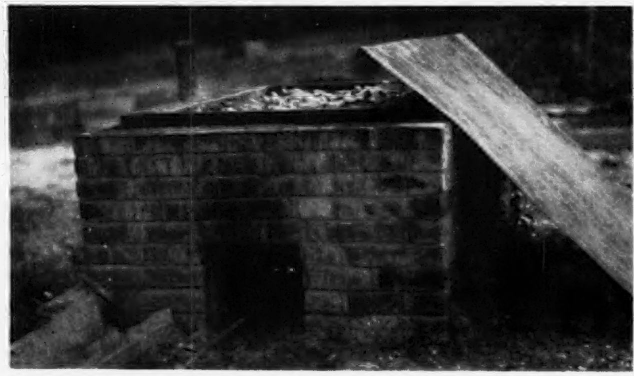
Dozens of installations were visited and tested from Massachusetts through Wyoming. An alarmingly small number of those cooking garbage were doing a good job. There were not enough to spot one in each geographic region of the United States. The need for widespread distribution of good equipment design was quite evident. It was feared the disease would break out some place where the cooking was not being done properly, which might lead the feeder to believe cooking did not prevent the disease. In many cases where cooking temperatures had been measured, they were found to be too low to kill the virus.

The need for engineering help on this problem was obviously great. We found most feeders willing to accept advice when it was made available to them. The next step was to put our advice in writing, so that any feeder could get it. Within six or seven months material was published and distributed to every state in the country. This was given wide distribution among the garbage feeders to improve their cooking equipment. While this information doubtless helped raise the quality of garbage heat-treatment, yet there was still need for word-of-mouth education. Accordingly, an engineer was sent into various locations to demonstrate good and poor design to the feeders. This is being followed by visits to local installations where temperatures can be measured. Following the visits, local offices are in a much better position to give competent advice.

EDITOR'S NOTE: Supplement No. 1 of the bulletin, entitled "Equipment for the Heat-Treatment of Garbage to Be Used for Hog Feed," was issued February, 1954, by the U.S. Department of Agriculture and the U.S. Public Health Service, Washington, D.C., and appears to be the most recent information issued by public agencies on this subject.

Paper presented at a meeting of the Washington (D.C.) Section of the American Society of Agricultural Engineers, at Washington, February 12, 1954.

The author—PAUL JAMES—is mechanical engineer, animal disease eradication branch, U.S. Department of Agriculture.



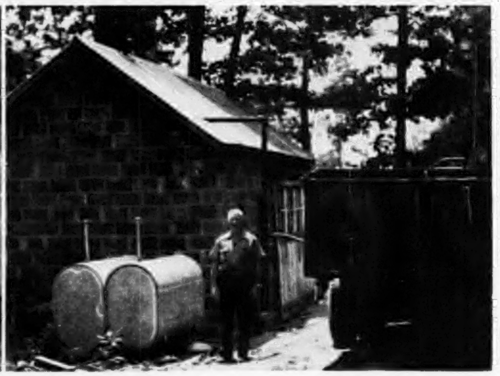


Fig.1 *(Left)* An example of good design for a garbage-cooking installation • Fig. 2 *(Right)* This view shows a steam-injection setup for cooking garbage in a garbage-collection truck

Lethal Effects of Electrons on Insects which Infest Wheat, Flour, and Beans – Part II

V. H. Baker, O. Taboada, and D. E. Wiant
Member ASAE Member ASAE

THIS report is a continuation of a paper **(1)*** in which was discussed the purpose of tests, review of literature, a description of the Van de Graaff electron accelerator, units of radiation dosage, method of testing and results of baking and germination tests. It is recommended that Part I of this paper be reviewed before this paper is studied.

The object of Part II is to present further information on dosage calculation, penetration of electrons into and temperature rise in samples, culture of insects for tests, and to report further information on the effects of accelerated electrons on wheat, flour, and beans as well as the effects on certain insects which infest these commodities.

DOSAGE CALCULATIONS

Method of Calculating Dosage

The method used for calculating dosage of ionizing electrons was essentially the same as that presented by Trump et al **(2)**. Their formula for dosage calculation is:

$$P = \frac{EI}{\pi\,(D/2)^2}\,K_1\,K_2 = \frac{4\,EI\,K_2}{\pi\,D^2} \times \frac{K_1}{R} \quad \text{watts per gram} \qquad [1]$$

where P=power absorbed per gram of material distributed evenly over container of diameter D in centimeters

E=accelerating voltage

I=total beam current to container of diameter D

R=depth of material in grams per square centimeter

K_1=fraction of total power absorbed in range R

K_2=back-scatter factor.

This paper was prepared expressly for AGRICULTURAL ENGINEERING. A summary of this paper, sponsored by the ASAE Committee on Agricultural Processing, was presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1953. Authorized as Journal Paper 1617 of the Michigan Agricultural Experiment Station.

The authors—V. H. BAKER, O. TABOADA, and D. E. WIANT—are, respectively, professor of agricultural engineering, Virginia Polytechnic Institute, formerly on leave at Michigan State College, and graduate student in entomology and professor of agricultural engineering, Michigan State College.

Acknowledgment: The authors gratefully acknowledge the cooperation of O. R. Woods and N. A. Drake of the physics department of The Upjohn Co., Kalamazoo, Mich., and of The Upjohn Co. for the use of their Van de Graaff electron accelerator.

*Bold-faced numbers refer to the appended references.

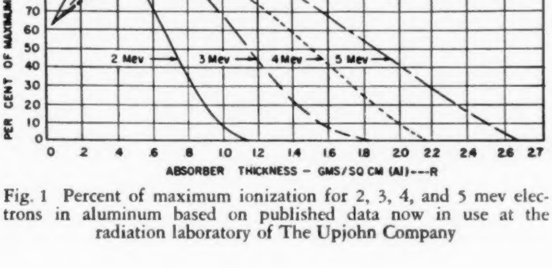


Fig. 1 Percent of maximum ionization for 2, 3, 4, and 5 mev electrons in aluminum based on published data now in use at the radiation laboratory of The Upjohn Company

The value of K_1 may be obtained for 2, 3, 4, and 5 mev (million electron volts, see Part I for definition) electrons from Fig. 1 by dividing the area under the curve for a sample thickness R in grams per square centimeter by the total area under the curve for a given mev. K_1 and K_1/R have been calculated for 2 mev electrons by using this method (Fig. 2) and are used at the radiation laboratory of The Upjohn Company for calculating dosages of 2 mev electrons. The data in Fig. 1 is based on published data for aluminum. Since R is in grams per square centimeter, these curves can be used for most homogenous materials. Trump **(2)** points out that K_2 can be kept close to unity by irradiating the sample in a dish made of a material having a low atomic number. Before an actual dosage problem is solved, it will be desirable to know the penetration of accelerated electrons into the materials to be irradiated.

Penetration of Electrons into Wheat and Flour

In order for electrons to be effective in ionizing tissue and thus cause lethal effects, the energy of the electron must be absorbed by a material as the electron travels through the material. Knowing the actual penetration depths of accelerated electrons into a material is of little value unless some information is available on how the energy is dissipated in the material. The percent of maximum ionization curve for 2 mev electrons for wheat (Fig. 3) was calculated from the 2 mev ionization curve of aluminum in Fig. 1, using a density of 0.74 g per cm³ for wheat and flour.

It is important to note that, although the ionization curves in Fig. 1 were determined for aluminum, these same curves may be used for other materials. This is due to the

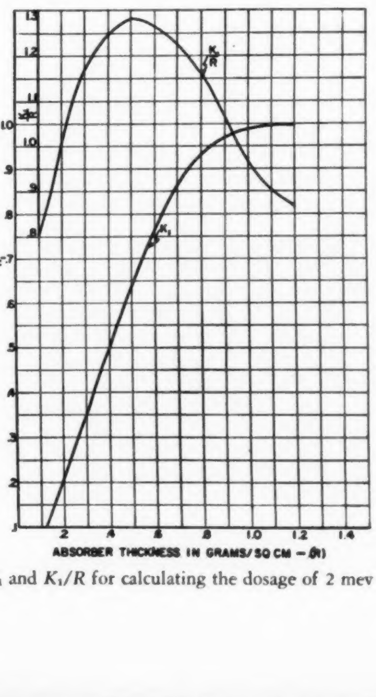


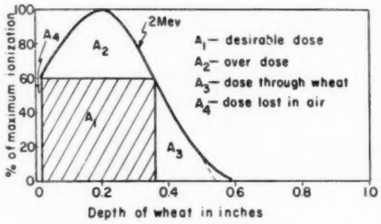
Fig. 2 K_1 and K_1/R for calculating the dosage of 2 mev electrons

fact that depths of material in R units, (grams per square centimeter) are independent of the type of material. Therefore, when the curves in Fig. 1 have been established, the depth in inches or centimeters of penetration of accelerated electrons into materials other than aluminum may be calculated.

The depth of penetration in inches of 2 mev electrons into wheat or flour may be calculated by using a density of wheat or flour of 0.74 gm per cm^3 and by assuming that the layer of wheat or flour is to receive 60 percent of the ionization dose on the top and bottom of the layer. From Fig. 1 the value of R which satisfies these conditions is about 0.65 gm per cm^2. In order to convert to inches of wheat or flour, it is necessary to divide by the density of wheat, 0.74 gm per cm^3, which gives the depth in centimeters. Dividing by 2.54 cm per in gives the depth in inches as:

$$\frac{0.65 \text{ gm per cm}^2}{(0.74 \text{ gm per cm}^3)(2.54 \text{ cm per in})}$$
$$= 0.35 \text{ in of wheat or flour}$$

This same procedure may be used for any material by selecting the desired value of R and dividing by the density of the material.



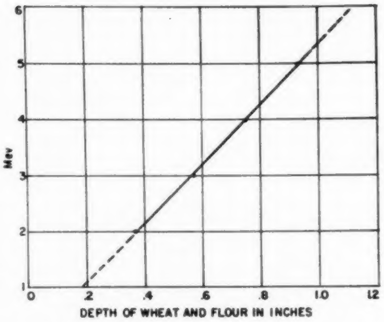


Fig. 3 *(Above)* Depth of penetration of 2 mev accelerated electrons in wheat (density, 0.74 g per cu cm) with 60 percent of maximum ionization at top and bottom layer of wheat • Fig. 4 *(Right)* Depth of penetration of accelerated electrons in wheat and flour with a density of 0.74 g per cu cm, with 60 percent of maximum ionization at the top and bottom of the irradiated layer

Choice of Percent of Maximum Ionization Entering and Leaving Sample

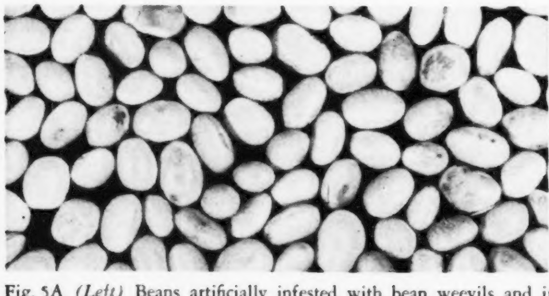
It is desirable to choose a thickness of sample so that the percent of maximum ionization at the top and bottom of the sample is the same. The percent of maximum ionization for 2 mev electrons in wheat and flour is shown in Fig. 3. A dose of 60 percent of maximum ionization was chosen for this figure. The physical shape of this curve shows that the maximum ionization occurs below the surface of the material irradiated. This apparently is due to the fact that electrons and other ionizing particles give up more energy per differential path length as their energy becomes less (down to a certain limit). The area A_1 represents the desirable dose, A_2 represents the overdose, A_3 is the dose lost through the sample, and A_4 represents the dose lost in the air above the sample. The ideal dose, A_1, should be a value such that A_1 is a maximum with the sum $A_2+A_3+A_4$ a minimum. This condition is approximately satisfied when the electrons on entering and leaving the sample produce 60 percent of the maximum ionization in the sample. With 2 mev electrons, maximum energy can be transferred to the sample; i.e., K_1/R is a maximum in equation [1] and Fig. 2, by using a depth of product between 0.4 and 0.65 g per sq cm, which would be about 0.35 in of wheat or flour.

If wheat or flour is irradiated on a conveyor belt and 60 percent of maximum ionization is to be obtained in the top layer of flour and in the layer of flour next to the conveyor belt, then the maximum depth which can be treated is about 0.35 in for 2 mev electrons, and about 0.57 in for 3 mev electrons. These depths may be increased when the material is irradiated from both top and bottom. When 60 percent of maximum ionization in the top and bottom layers is assumed and losses in the conveyor belt are neglected, a depth of approximately 0.9 in of wheat or flour can be treated, if irradiated from top only, with 5 mev electrons (Fig. 4), or a depth of more than 2.0 in can be treated, if irradiated from top and bottom, with 5 mev electrons.

Dosage Calculations and Rate of Treatment of Product

An example of calculations used to obtain the exposure time for a dose of 1,000,000 rep of 2 mev electrons in a stationary 9-cm-diam sample is presented. By definition, 1×10^6 rep $= 8.38$j (joules) per gram of tissue. Suppose that the beam current is 50μa (microamperes) and that the depth of wheat or flour chosen to be irradiated is about 0.65 g per cm^3 (from Fig. 1). From Fig. 2, $K_1/R = 1.25$, Assume $K_2 = 1$. Then from equation [1]

$$P = \frac{4(50\times10^{-6})(2\times10^{6})\,1}{\pi(9)^2}\,(1.25)$$
$$= 1.96 \text{ w per g} = 1.96 \text{ j per sec-g}$$



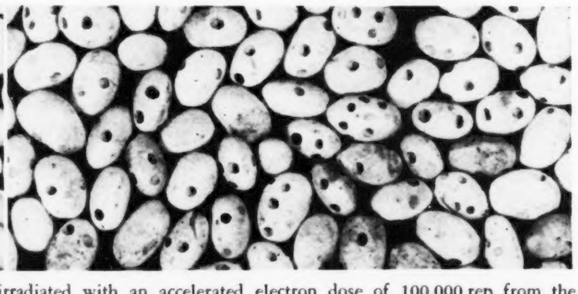


Fig. 5A *(Left)* Beans artificially infested with bean weevils and irradiated with an accelerated electron dose of 100,000 rep from the 2-million-volt Van de Graaff electron accelerator. Picture taken after an incubation period of about 43 days from date of treatment. • Fig. 5B *(Right)* Beans artificially infested with bean weevils used as a check sample (untreated). Picture taken after an incubation period of about 43 days from date of treatment of sample shown in Fig. 5A

The time required to deliver an average dose of

1×10^6 is 8.38 j per g ÷ 1.96 j per sec-g = 4.27 sec.

By this same formula, with the same conditions, the time required for 500,000, 100,000, and 10,000 rep is 2.13, 0.427, and 0.0427 sec, respectively.

It should be pointed out here that in this paper, when calculating the dose of accelerated electrons on insects, the density of the insect was assumed to be 0.74 g per cu cm when the insects were mixed with flour and wheat, and an insect density of 1.0 g per cu cm was assumed when the insects were irradiated in plain dishes with no flour.

By knowing the time required to administer a given dose to a stationary sample, it is a simple matter to calculate the belt speeds for products to be treated on a conveyor belt. In actual practice the belt speed may be set, which in turn would set the exposure time. If this is the case, then the beam current could be adjusted to obtain the desired dose in rep.

Suppose that it is desired to calculate the rate of flow of wheat or flour receiving a dose of 100,000 rep. Assume that a 2 mev generator is available and that 200 μa of beam current is dissipated in the wheat. This would be 400 j per sec, or a power of 400 w. Using the value of 0.838 j per g for 10^5 rep, then the rate of flow is about

$$\frac{400 \text{ j per sec}}{0.838 \text{ j per g}} = 478 \text{ g per sec, or}$$

$$\frac{478\times60\times60}{453.9} = 3800 \text{ lb per hour.}$$

If the dosage is reduced to 10,000 rep, the rate of flow would be 38,000 lb per hr.

Table 1 lists formulas which may be used to calculate the rate of flow of wheat and flour (density, 0.74 g per cm^3) receiving doses of 2, 3, 4 and 5 mev electrons. The depths in Table 1 were obtained from Fig. 4. By the use of the formulas in Table 1, various conveyor belt widths (W in in) and belt speeds (S in fpm) may be used to calculate a desired flow rate, or if the flow rate is set, the width and speed of the belt may be calculated. When the rate of flow has been established, the beam current may be adjusted to give the desired dosage in rep.

TABLE 1. FORMULAS FOR CALCULATING RATE OF TREATMENT OF WHEAT AND FLOUR ON A CONVEYOR BELT

W = Width of conveyor, in S = Speed of conveyor belt, fpm

Depth, in	Mev	Rate of flow formula
0.35	2	$WS\times$ 6.8 = lb per hr
0.57	3	$WS\times$ 11.2 = lb per hr
0.75	4	$WS\times$ 14.7 = lb per hr
0.94	5	$WS\times$ 18.4 = lb per hr

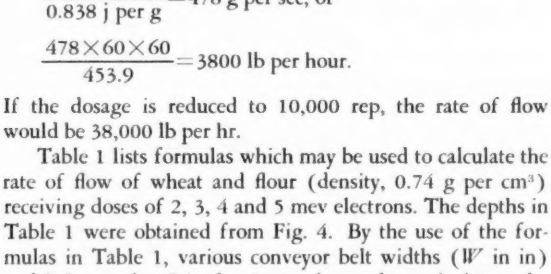


Fig. 6 Growth of untreated and treated Cornell 595 wheat *(left)* and Michigan navy beans *(right)* two weeks after planting in greenhouse

At 2¢ per kwhr, the approximate cost of electric energy for a dose of 1×10^5 rep at an efficiency of 10 percent is

$$\frac{400 \text{ w}\times 1 \text{ hr}}{1000\times0.10}\times\frac{2}{\text{kwhr}}\times\frac{3800}{2000}$$

= 15.2¢ per ton, or 0.76¢ per 100 lb.

With a dose of 10,000 rep, the cost of energy is about 1.52¢ per ton.

The Distribution of Current Density

Curves for the distribution of 2 mev cathode rays in a traverse plane 40 cm from the 3-mil aluminum window for the Van de Graaff electron accelerator have been presented by Trump **(2)**. Data from these curves enable one to calculate the maximum and minimum doses distributed across a given sample. The distribution of the dose across the object may be controlled by selecting the thickness of the scattering window, the absorber depth, and the irradiation distance. The thickness of the scattering window installed in the 2 mev Van de Graaff electron accelerator at The Upjohn Company was chosen so that the distribution of the unscanned cathode ray beam across the samples being irradiated was rather uniform.

Calculations for Temperature Rise in a Given Sample

To calculate the temperature rise in a given material receiving a dose of accelerated electrons, the following formula is used:

$$Q = W\,(sh)\,(T_2-T_1) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

where Q is the energy required to heat material of weight W and specific heat (sh) from an initial temperature T_1 to a final temperature T_2.

Suppose it is desirable to calculate the temperature rise for one gram of wheat or flour receiving a dose of 100,000 rep using equation [2] and a value of

Q = 100,000 rep = 0.20 calories per gram, and sh = 0.4

By definition 1 rep = 83.8 ergs per gram, then since

1 j = 10^7 ergs, and 4.186 j = one calorie,

$$100{,}000 \text{ rep} = \frac{0.838 \text{ j per g}}{4.186 \text{ j per calorie}} = 0.20 \text{ calories per g}$$

$$\text{and } T_2-T_1 = \frac{Q}{W\,(sh)} = \frac{0.20}{0.4(1)} = 0.5 \text{ C temperature rise.}$$

The temperature rise for one gram of flour receiving a dose of 500,000 rep would be about 2.5 C.

TESTS CONDUCTED

A total of ten tests were conducted using the Van de Graaff electron accelerator. These tests include germination tests and irradiations for the wheat and flour later used in the baking tests (Part I). Insects were irradiated in the first seven tests. The procedure for each test was similar. (A general description of procedure was presented in Part I with a specific procedure for two tests. This description will suffice, since the procedure given, together with the tabulated data for each test [3, 4], will enable one to repeat the tests.)

The insects for all tests were grown in a constant-temperature, constant-humidity incubator in the entomology department at Michigan State College, and samples for each series of tests were prepared in the entomology laboratory **(3)**. After preparation, the samples were placed in an in-

sulated box and transported by automobile from East Lansing to The Upjohn Company at Kalamazoo, Mich. The samples were then irradiated and returned to East Lansing the same day and again placed in the incubator. Observations were made at intervals after each test.

Further Results

Results of the tests conducted, using the granary weevil and flour beetle, were presented in Part I. Tests conducted using Michigan navy beans infested with *Acanthoscelides obtectus*, (Say), (bean weevil) show that an electron dose of 10,000 rep was lethal to 100 percent of adult bean weevil, one week after treatment. Fifteen adult bean weevils were irradiated for each test. These adults were irradiated in 9-cm-diam petri dishes containing 20 g of Michigan navy beans. An electron dose of 100,000 rep was lethal to 73 percent of the adults 48 hr after treatment, and to 100 percent of adults one week after treatment.

Samples of artificially infested Michigan navy beans which received a dose of 1×10^5 rep and a sample used as a check (untreated) as they appeared after an incubation period of about 43 days are shown in Figs. 5 and 5B. These pictures show that a dose of 1×10^5 rep is sufficient to prevent the insect from damaging the beans.

The growth of treated and untreated Cornell 595 wheat (left) and Michigan navy beans (right) two weeks after planting in a green house, is shown in Fig. 6. These pictures show that a dose as low as 10,000 rep was detrimental to wheat and bean seed.

Effects of Accelerated Electrons or Cathode Rays on Vitamins

Some effects of accelerated electrons and X rays on vitamins and enzymes have been reported **(5, 6, 7, 8, 9)**. Niacin in a concentration of 100 micrograms per milliliter was not destroyed by X rays in total dosages between 125,000 and 850,000 roentgens **(5)**. The amount of destruction of niacin by cathode rays increased with dilution. Goldblith and Proctor **(7)** reported that there was no appreciable effect of a dose of 10,000 rep on a 100 micrograms per milliliter solution of riboflavin and carotene. There was about 95 percent retention of riboflavin with the same dilution as above, when treated with a dose of 100,000 rep. There was only 40 percent retention of riboflavin and about 65 percent retention of carotene when this same percentage of solution received a dose of about 500,000 rep. Other important observations on the percent retention of riboflavin were also made by Goldblith and Proctor **(7)**.

These same investigators report 98 percent of a 100 microgram per milliliter solution of ascorbic acid was retained when irradiated with an X ray dose of 10,000 roentgens, whereas only 37 percent of the ascorbic acid in a 100 microgram per milliliter solution was retained when irradiated with a dose of 100,000 roentgens.

Brach **(9)** reported that there was no loss of activity when the enzymes trypsin, pepsin, and papain were irradiated with a dose of 3×10^6 rep of accelerated electrons. The enzyme diastase from barley showed a 14 percent loss in activity when irradiated with a dose of 9×10^5 rep. The enzyme urease from soy flour showed a loss of 14 percent when irradiated with a dose of 2×10^6 rep. The loss in activity in other enzymes, when irradiated with doses up to 8×10^5 rep was reported, but in no case was the loss in activity greater than 15 percent **(9)**. All the above doses reported were greater than necessary for insect control in wheat, flour, and beans. The loss in enzyme activity should be less with reduced doses.

When accelerated electrons are used to sterilize foods certain side effects may be produced which may cause changes in color, flavor, and sometimes texture. Studies have been made by Proctor et al **(10, 11)** in an effort to minimize these changes. Irradiation of materials in inert atmospheres or in a vacuum and in the frozen state minimizes but does not prevent such changes. Most of the dosages used by Proctor and his associates were for micro-organism control and are much higher than the dosage required for insect control.

SUMMARY

Further information on the effects of accelerated electrons on insects which infest wheat, flour, and beans is presented as well as information on the method used to calculate dosage, penetration of electrons into wheat and flour, rate of treatment of product, cost of electrical energy for a given dose in rep, distribution of current density, calculation of the temperature rise in a given sample, and a review of literature on the effects of accelerated electrons on vitamins and enzymes.

The use of accelerated electrons to stop adult insects from reproducing and to sterilize insect eggs in wheat, flour and beans offers promise for insect control; however, this process is still in the experimental stage. Further research is necessary before this process can be recommended for industrial use.

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Friction Coefficients of Some Agricultural Materials

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GENERAL SUMMARY

NO reliable basic data were available on the friction coefficients of chopped hay, straw, or silages on galvanized steel at varying velocities and unit normal pressures. Laboratory tests were conducted to determine appropriate coefficients for use in the design of materials-handling equipment.

Static and sliding-friction coefficients were determined by two test methods. Polishing of the steel surface reduced the coefficient for dry materials, but had a lesser effect on the coefficient for moist materials. There was a distinct tendency toward higher static coefficients for moist materials at the lower unit pressures. There were only small effects on the sliding coefficients of any material as a result of varying sliding velocities or unit pressures.

As a result of these tests, it is possible to recommend tentative values of friction coefficients for galvanized steel within the velocity and pressure ranges investigated. These values, together with the range of values found in the tests, are as follows:

CHOPPED HAY AND STRAW

	Range found	Recommended value
Static coefficient	0.17–0.42	0.35
Sliding coefficient	0.28–0.33	0.30

SILAGES

	Range found	Recommended value
Static coefficient	0.52–0.82	0.80
Sliding coefficient	0.57–0.78	0.70

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

The author—DONALD W. RICHTER—formerly research assistant in agricultural engineering, Cornell University, now market specialist, Armco Steel Corp.

Objective

The trend toward use of mechanical equipment for handling materials on the farm has emphasized the need for accurate basic design data. Friction coefficients for use in the design of conveyors, elevators, unloaders, and other equipment are examples of data needed for design of equipment components and for selection of proper power units.

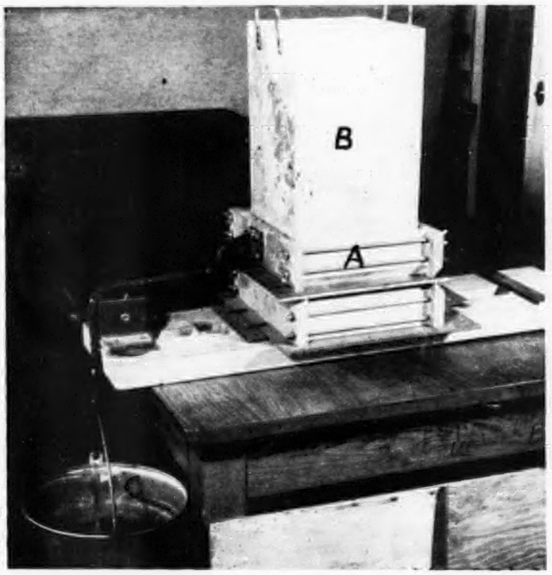
The object of this investigation was to determine appropriate friction coefficients for use when chopped hay, chopped straw, corn silage, or grass silage is to be moved over a galvanized steel surface.

Review of Literature

Hodges **(3)*** reported the power required to operate a canvas-apron wagon unloader, and stated that the power requirement for a chain-and-slat conveyor was not significantly different. Converting the power data to give friction coefficients, it was found that 0.75 was an average coefficient for corn silage on wood. Barger et al **(1)** reported friction coefficients of corn silage from 0.79 to 0.96 for false endgate wagon unloaders, depending on construction and surface conditions. The coefficient for sheet metal was 0.88 with a slant endgate. The data reported by both of these workers were obtained at slow speeds and were influenced by friction on such other parts as endgates, chains, canvas, and sides of the box. A further limitation was that it was not determined whether the coefficients would apply at higher speeds or at different unit pressures.

Hintz and Schinke **(2)** reported coefficients of sliding friction for chopped corn and alfalfa on steel at sliding velocities from 0 to 6000 fpm. Above 1000 fpm, the friction coefficients for both materials did not vary greatly from 0.5. Below 1000 fpm results varied widely, and no valid con-

*Bold-faced numbers refer to the appended references.



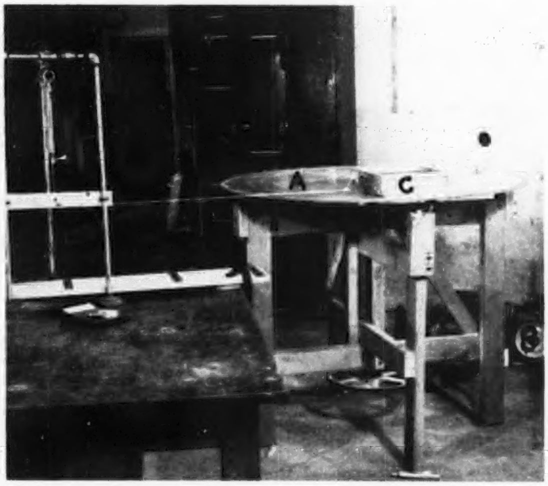


Fig. 1 *(Left)* Apparatus for tests of static-friction coefficient. Wood frame (A), container for weights (B), and pail for sand (C) • Fig. 2 *(Above)* Apparatus for tests of sliding-friction coefficient. Revolving disk (A), drive unit (B), wood frame (C), and spring scale (D)

clusions could be drawn. Thus there were no reliable basic data to cover the usual conveyor speeds of 0 to 500 fpm or the effect of varying unit pressures.

TEST PROCEDURE

Static Coefficient

A sheet of galvanized steel 12 in square was mounted on a rigid base. A wooden frame was placed on the sheet and filled with the material to be tested. The unit pressure was varied by placing weights on a platen resting on the material. The frame was raised a fraction of an inch above the sheet so all weight was transferred only through the material. Wooden frames 6 in square and 9 in square were used at the same unit pressure to determine whether the size of the frame affected the results.

A transverse force was applied to the frame by a sash chain running over a pulley to a pail. Sand was slowly added to the pail until the material started to slide over the galvanized sheet. The weight of the pail of sand gave measurement of the friction force. The test apparatus is shown in Fig. 1.

Sliding Coefficient

The testing method was similar to the one used by Hintz and Schinke (**2**). A 46-in-diameter disk of 20-gage galvanized steel was mounted on a 48-in-diam disk of 5/16-in masonite. The disks were keyed to a vertical arbor. A variable-speed drive belted to the arbor gave a range in surface speeds at a 16-in radius of 5 to 640 fpm.

The material to be tested was placed in the 9-in wooden frame and the platen and weight applied. A cord tied to the frame was led over a pulley to a spring scale. When the disk was rotated, the friction force was read from the scale. Fig. 2 shows a general view of the apparatus.

DISCUSSION OF RESULTS

Static Coefficient

The first tests were started on the galvanized sheet in its original condition, and progressed as shown in Fig. 3. The explanation of Fig. 3 is as follows:

Part A. In the initial tests, it was observed that the friction coefficient for both materials decreased steadily as the tests progressed, regardless of the normal pressure applied. This resulted from polishing of the surface by the movement of the material.

Part B. The sheet was then extensively polished with abrasives to hasten the decrease in friction coefficient.

Part C. Further polishing by the tests themselves continued to give decreases in the coefficient.

Parts D & F. An electric-motor-driven reciprocating polisher using chopped hay as the polishing medium was used.

Parts E & G. A surface condition was finally obtained for which the friction coefficient approached a minimum.

This whole process required nearly three days, but variations in the processes made it impossible to represent time units on the absicissa in Fig. 3. Polishing of the sheet decreased the static-friction coefficient for chopped hay and straw from an initial value of 0.42 to a final value of 0.17. In the final condition, the zinc coating had been completely worn off in two small areas and the surface was almost mirrorlike in appearance, a condition often noted in materials-handling equipment after many hours of use.

Samples of chopped grass and corn silage did not give a decrease in static friction coefficient as a result of polishing of the sheet. The average static friction coefficients were 0.67 and 0.59 before polishing and 0.68 and 0.59 after polishing for chopped grass and corn silage, respectively.

After the sheet had been polished and the friction coefficient values stabilized with respect to time, a series of tests for each material was run to determine the effect of normal pressure. Each series consisted of 24 tests, using two frame sizes, a series of normal pressures, and three replications. The tests were randomized within each replication to eliminate bias resulting from changes in the testing technique, weather, or other conditions varying with time.

Results of these tests are given in Fig. 4. There was a definite increase in the static coefficient for chopped grass and corn silage as the unit pressure decreased. This could be a result of adhesion associated with the high moisture content of these materials, which would have a greater effect at the lower unit pressures. The effect of unit pressure on the coefficients for the dry materials, chopped hay and

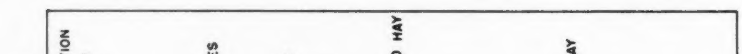


Fig. 3 *(Left)* Change in static-friction coefficient of chopped hay and straw on galvanized steel with progressive surface treatments. Each point represents the average of two or three tests • Fig. 4 (Right) Variation in static-friction coefficient with intensity of pressure on highly polished galvanized steel for four samples of material. Each point represents the average of six tests

straw, was insignificant. There was no effect on the coefficient of any material resulting from the size of the frame used, except as the size influenced the pressure intensity.

Sliding Coefficient

The galvanized disk never became as highly polished as the sheet used in the static tests, even though abrasives were used to smooth the initial roughness. Values for the static coefficient were obtained on this sheet to compare with the values obtained on the more highly polished sheet. The average static coefficient for chopped straw was 0.35 compared to 0.21 for the previous tests, indicating a considerable difference in surface roughness. For corn silage the average coefficient was 0.73 compared to 0.59.

Chopped straw was used to represent the dry material, in a test series consisting of three replications of each of four normal pressures with speeds from 0 to 320 fpm. The tests were randomized with respect to time. A few tests at 640 fpm gave substantially the same coefficient as at lower speeds. One test series was run partly on one afternoon and partly the next morning. An increase of 13 percent in the sliding coefficient of friction occurred over this interval, possibly as a result of a change in relative humidity or slight oxidation of the zinc surface. A similar or larger change might be expected in materials-handling equipment.

TABLE 1. SUMMARY OF TESTS OF SLIDING FRICTION OF CHOPPED STRAW ON POLISHED GALVANIZED STEEL

(Each figure is the average of three tests)

Sliding velocity	Normal pressure, lb/ft² 14.2	28.5	57	Average
fpm	Friction coefficient			
0	0.33	0.36	0.36	0.35
5	0.30	0.29	0.28	0.29
10	0.29	0.30	0.30	0.30
20	0.29	0.30	0.30	0.30
40	0.30	0.30	0.30	0.30
80	0.30	0.30	0.29	0.30
160	0.30	0.30	0.30	0.30
320	0.31	0.30	0.33	0.31
Average (sliding)	0.30	0.30	0.30	0.30

Results of these tests are given in Table 1. The average sliding-friction coefficient for chopped straw was 0.30. There was no significant effect resulting from changes in unit pressure or sliding velocity.

TABLE 2. SUMMARY OF TESTS OF SLIDING FRICTION OF CORN SILAGE ON POLISHED GALVANIZED STEEL, 73 PERCENT MOISTURE

(Each figure is the average of three tests)

Sliding velocity	Normal pressure, lb/ft² 5.6	8.9	14.2	28.4	Average
fpm	Friction coefficient				
0	0.79	0.80	0.72	0.60	0.73
5	0.68	0.73	0.62	0.60	0.66
10	0.70	0.70	0.65	0.61	0.66
20	0.70	0.70	0.67	0.66	0.68
40	0.70	0.73	0.71	0.71	0.71
80	0.70	0.67	0.73	0.73	0.71
160	0.70	0.64	0.70	0.74	0.69
320	0.74	0.70	0.66	0.57	0.68
Average (sliding)	0.70	0.70	0.68	0.66	0.68

Corn silage and grass silage were tested at 73 percent moisture, wet basis. The normal pressures differed slightly from the ones used for chopped straw, but the tests were otherwise the same. Results are given in Tables 2 and 3. The average sliding-friction coefficient for both materials was 0.68. At sliding velocities below 20 fpm, corn silage tended to give slightly higher friction coefficients at low normal pressures. Grass silage, on the other hand, tended to give higher coefficients at the higher normal pressures. Otherwise, neither the various unit pressures nor sliding velocities had any significant effect for the silage samples.

During the tests it was observed that a substantial decrease in friction coefficient occurred if the silages dried to a certain point. Fresh samples were used as often as necessary to prevent this factor from influencing the tests.

CONCLUSIONS

1 The ultimate aim of friction tests is to aid in the design of materials-handling equipment. For this purpose, the static-friction coefficient of chopped dry hay and straw may be considered as 0.4 on new galvanized steel and 0.2 on the same material after extended polishing. Considering the time necessary for polishing, a power unit based on a static coefficient of 0.35 and a sliding coefficient of 0.30 is suggested for velocities below 640 fpm, if the equipment is to handle only these materials.

2 For chopped grass and silages, a static-friction coefficient of 0.80 and a sliding-friction coefficient of 0.70 should give adequate design on galvanized steel in either a new or a polished condition, for the pressure and velocity ranges investigated.

3 Allowance should be made for the effects of weathering of the galvanized sheet and variations in moisture content of the material. Since these tests did not evaluate such conditions, further investigations are needed to determine their effects.

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1 Barger, et al. Results of tests on mechanical loading devices for chopped forages. AGRICULTURAL ENGINEERING 30 : 223, May, 1949.

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3 Hodges, L. H. The design of a general-purpose farm wagon rack for mechanical unloading. AGRICULTURAL ENGINEERING 30:124, March, 1949.

TABLE 3. SUMMARY OF TESTS OF SLIDING FRICTION OF GRASS SILAGE ON POLISHED GALVANIZED STEEL, 73 PERCENT MOISTURE

(Each figure is the average of three tests)

Sliding velocity	Normal pressure, lb/ft² 5.6	8.9	14.2	28.4	Average
fpm	Friction coefficient				
0	0.64	0.80	0.82	0.78	0.76
5	0.63	0.65	0.66	0.67	0.65
10	0.63	0.65	0.67	0.70	0.66
20	0.63	0.65	0.69	0.71	0.67
40	0.65	0.67	0.69	0.72	0.68
80	0.63	0.63	0.73	0.74	0.68
160	0.63	0.61	0.75	0.74	0.68
320	0.58	0.73	0.68	0.78	0.69
Average (sliding)	0.63	0.66	0.70	0.72	0.68

Our Shrinking Farm Lands

R. L. Adams

THE title of this paper deals with a subject of growing interest to more and more thoughtful people, people who have at heart the future welfare of the country and with special reference to the place that agriculture may — and should — play in the land-planning sprees that are infesting the land.

One reason that one cannot be more specific in treating a subject of this nature is that there is little available literature dealing with the trends and statistics of land utilization, its effect on agriculture, and what constitutes wise procedure for the years ahead.

However, some material is available that is of interest. By way of introduction, following are data from (Tables 9, 10, and 13) appearing in the "Report of the Director of the Federal Bureau of Land Management (Statistical Appendix as of June 30, 1952):"

GROSS AREA OF WITHDRAWALS FOR NATIONAL PARKS, MONUMENTS, WILDLIFE RESERVES, AIR NAVIGATION SITES, AND STOCK DRIVEWAYS

Total for United States	41,216,758 acres
California	4,478,977 acres

Of this, national parks in California utilize 1,706,638 acres and national monuments, 2,397,264 acres.

AREA OF NATIONAL FORESTS

Total for United States	208,201,125 acres (or an area equal to twice that of California)
California	25,078,194 acres (or about 25 percent of California's land area)

AREAS WITHDRAWN SINCE JULY 1, 1937, FOR MILITARY AND OTHER DEFENSE PURPOSES

Total for United States	16,273,180 acres
In California and by departments, the data are:	
Army and Air Force	733,267
Navy	854,622
Interior	8,424
Other	30,438
Total	1,626,751

In presenting these figures, there is no thought of combating the extensive transfer of lands to various uses not necessarily related to agriculture. However, such impressive totals may well raise the question as to a survey to determine the value of these withdrawals from possible agricultural use. I know this is a touchy subject but, in view of the lack of data, a decision as to what is a wise course to follow in the future is difficult to ascertain.

Most people if they give any thought to this matter at all—jump to the conclusion that this is the farmers' problem. Their attitude is: "Why worry us? It is up to the farmer to be concerned. He has to have us city dwellers in order to sell his products." However, the farmer can only produce what his soil, climate, topography, and growing conditions generally will permit. If our present era of plenty does become an era of scarcity, it will not be the farmer who will suffer first. He will continue to eat. Others will have to get along with what is left.

So, we say, as a matter of fact, this problem is — or should be — of greatest concern to the non-rural population. What they can do about it is something else again.

I say the city dweller eventually may have cause to worry. Note that 100 years ago most everyone lived on farms. Today, as one writer puts it:

> "Each year a larger percentage of the total (population) have put up their Christmas trees in town homes and have had to patronize the corner market for the 'fixin's' to grace their festive tables.
>
> "Today, only about 15 percent of our country-wide population is on farms. The other 85 percent live in towns and depend on the 15 percent for their food and for many of the raw products which are used in the factories where they work."

Each year increases the number of people to be fed. According to statistical evidence, the population within the United States has climbed from (in round numbers) 122,775,000 in 1930 to 131,669,000 in 1940 to 150,697,000 in 1950. During the last decade, the average increase has been nearly 19,000,000 or at the rate of about 1,900,000 per year.

This brings us to another rather interesting conclusion. According to the statistics, our present standard of living on a nation-wide scale calls for 2.4 acres of tillable land per person. An increase of nearly 2,000,000 people yearly can call for 4,800,000 acres of foodstuffs and raw materials, such as sugar beets for sugar making, cotton, fruits and vegetables for canning, and a host of things to meet our living needs.

You ask: "From where is this additional land coming?" Two possibilities emerge. First, there is the continuing development of new farming lands by drainage, irrigation, clearing cutover timber lands, and subduing brush. We are aware of the added acreage of irrigable lands traceable to the All-American Canal in the Imperial and Coachella valleys and the Columbia River project in the states of Washington, Idaho, Oregon, and Montana. Other projects may augment the present irrigated acreage, but I venture to say that these lands will be expensive to supply and serve, and in some cases the soils in such new projects leave much to be desired. Second, there is improvement in farming practices so that the present acreage produces more by use of such methods as demonstrated by the increasing use of better farming practices. More and better implements and machines will help. There may be other future offsetting factors. The growth of population may drop off, though this is not apparent in the near foreseeable future.

A couple of other possibilities could occur. Increased importation of certain foodstuffs — especially from Canada, Mexico, Cuba, and South America—generally is one. Another

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— and one that would cause a lot of squirming — would be by reducing our standard of living and tightening our belts.

Some will say: "It is preposterous to believe that our country will ever fall short of foodstuffs and raw materials. Look at the vast tracts of prairie and rolling plains." But what is overlooked is that much land is not suited to intensive farming — though grazing will be a continuing possibility. Let us look into this a bit.

California

Big as is California the state's land area utilized for farming is relatively small — and this is typical of the 11 western states and also several southern states, including Texas. For California, the Census shows but about 8,000,000 acres harvested in 1949, or 8 per cent out of a gross land area of something over 100,000,000 acres. The amount of all land in farms totals only about 36½ per cent; the rest is desert, mountains, forests, brush, residences, etc. Irrigated acreage totals nearly 1,000,000 acres.

The corn belt states offer relatively far more in the way of farmable land than does California — when weighed in terms of land use (not income since California's specialty fruit and vegetable crops bring in far more per acre than the general crop farming of the corn belt). My curiosity caused me to check over the 1950 census data. I chose Ohio, Illinois, and Iowa as typical.

Ohio reports nearly 200,000 farms; Illinois, 195,268; and Iowa, 203,159 — each more than California's 137,168.

As against California's 36½ per cent of land in farms, Ohio utilizes 79.9 per cent of its land area; Illinois, 86.5 per cent; and Iowa, 95.5 per cent.

Cropland harvested in terms of total land area in round numbers was given as 10 million acres in Ohio (or 39 per cent); Illinois, 20 million acres (57 per cent); and Iowa, 22 million acres (32 per cent). This is against California's 8 million acres (18 per cent).

As to average size of farm, California leads with 266.9 acres; Iowa is second with 168.7 acres; Illinois, 158.6; and Ohio, 105.2

Some irrigation is reported for Iowa (1,386 acres); Illinois, 1,510 acres; and Ohio, 5,706 acres. This is against California's 977,702 acres.

If, as is stated, we today farm in the United States a total of 380 million crop acres, which conceivably can be raised to 450 million — if conditions remain basically unchanged — then we can coast along for awhile. I base this statement on the figure of 2.4 acres per person needed for food and fiber. Another 70,000,000 acres would take care of 28 million people. Then, we would be smack on the deadline. At 2 million annual increase, that means the deadline could be reached in another 14 years.

"All right," you say, "we'll grant what you say. Now, where does it all lead to?" It is a fair question. The answer — in brief — is that you cannot "eat your cake and have it, too" — meaning you cannot have the present food-producing capacity and at the same time take out of production thousands of acres for dwellings, factories, roads, airplanes, fields, outdoor movies, etc., that frequently include excellent farming lands.

The Agricultural Picture Today

Notwithstanding the danger of boring this audience, we should delve into a few statistics. The situation as it affects our farming lands, in the relationship of food and population, will be considered along three fronts — the national picture, California's situation, and (as a sample of county affairs) Monterey County. Monterey County was chosen because it is one of the richest counties agriculturally, in California. It is responsible for vast shipments of lettuce (about 37,000 carloads during 1953, with substantial shipments of carrots, broccoli, celery, and other valuable vegetable crops). It has earned — and deserves the name — the Salad Bowl of the World. Yet only a relatively small portion of the county's acreage produces more than $100 million of agricultural wealth — 300,000 acres out of 2,127,360, or 14 percent. Another reason for choosing this county is that a new freeway is scheduled to traverse the entire valley, a distance of 85 miles or so. Many miles of this length lie close to the richest agricultural lands of the valley and, if the freeway is unwisely located, a lot of damage can be done by substituting pavements for crops.

Considering the national picture, it is found that various studies by many investigators have unearthed some startling figures.

As already pointed out, the nation's total population increased 8,900,000 in the decade 1930 to 1940 and by another 19,000,000 from 1940 to 1950. For 1953, the estimate is 160,000,000. The farm population, on the other hand, did not materially change. The number in 1930 was 53,800,000, the 1940 figure was 57,200,000 and the 1950 figure was 61,600,000. This means that the incoming increases in population are finding their way into the cities and into industry. So the worry of sufficient food can eventually concern the city people.

As highway traffic increases, so eventually new roads must be opened up and old ones widened, straightened,

(Left) A new subdivision at Salinas, Calif., on land capable of producing truck crops, sugar beets, or beans having a gross annual value up to $600 per acre • *(Right)* For every mile of this freeway, near Gonzales, Calif., 20 acres are permanently removed from cultivation. This type of land will produce annually $800 to $1000 worth of lettuce, carrots, or broccoli per acre

and leveled. When this comes to pass, recall that a roadway of 160-ft width takes 20 acres out of each mile. A roadway of 120 ft utilizes 15 acres per mile.

As an example of what may emerge, you may be interested in a trial made by your speaker of the situation in Monterey County. Recently an enlarged freeway has gone under construction. If the new highway averages 160 ft, its course through the county will roughly approximate the use of land thus:

Rolling lands mostly in pasture but with some grain	310 acres
Dry-farmed land	212 acres
Mesa land (mostly farmed to beans, barley, alfalfa, and other field crops and with some irrigation)	936 acres
Rich, level, valuable land, mostly under irrigation, farmed to a variety of large income-producing vegetables, especially lettuce, carrots, broccoli, celery, etc.	252 acres
Grand total	1,710 acres

In viewing these data one may well ask: "Could the right of way be so planned that a lesser amount of good land would have had to be so sacrificed?" I do not know the exact figure, but it does look as if the saving could have been fairly substantial. However, I was surprised that the location did result in a minimum use of the better land. Moreover, much of the new work will be a widening (from 120 to 160 ft) rather than an entire relocation.

Residential Subdivisions

Another, and in California a not inconsequential, factor affecting the farming lands of the state is the many subdivisions that are taking place on all sides. Nearly every town has its building spree. It is not surprising when one recalls that the population in California has grown from about 5,677,000 in 1930 to 6,907,000 in 1940 and 10,586,000 in 1950.

So we find the number of dwellings in California rose from 2,138,343 structures in 1940 to 3,333,406 10 years later, or at the time when the 1950 Census was taken. This represents an average yearly gain of approximately 120,000. If we figure 6 dwellings to an acre, there has been a withdrawal figure of 20,000 acres a year. If these go on good farming land, then the food production is bound to be accordingly curtailed. Home gardening could offset a part of that loss, but my experience has been that only a small percentage of homeowners cares to fool with a garden, a few fruit trees, a milk goat, a dozen hens, and a couple of rabbits. As a matter of fact, land withdrawn for residential purposes appears to make far greater inroads than for freeways.

Effect on Farm Income

Up to this point we have been stressing loss of land area and, as a corollary, agricultural production. Let us, however, give some thought to loss of agricultural income. Taking Monterey County as an example, the effect on income varies from a low of $6.30 per acre to a high of $642.00. In this county, A. A. Tavernetti, county director of the California Agricultural Extension Service, has estimated the loss of income from the lands removed from agriculture at $642 per acre for the best land, mostly from crops of lettuce, broccoli, carrots, celery, and other vegetables, as against $53 for the dry-farmed land, mostly barley and beans, and $6.30 from the grazing land. No wonder landowners of this county regret the loss of the best land. As Mr. Tavernetti puts it: "By saving only the irrigated lands, or 6.5 per cent of the total county area, 85 per cent of the agricultural economy of the county can be preserved. Without proper planning, agriculture in Monterey County is destined to follow the very definite trend already apparent in a number of agricultural areas of the state. The solution lies in intelligent planning now. It will soon be too late!"

A Possible Remedy

The time is *now* for steps to be taken toward preserving our agricultural lands. The suggestion has been made several times during the past couple of years that a planning program should be developed that shall exempt farm lands from encroachment for industrial purposes, housing projects, military installations, air fields, etc. All are entitled to full consideration. All should be given the opportunity to become established, grow, and thrive. But thought may well be given to see that allocations are wisely made and the development held off of good farming lands.

I understand that any group of landowners in a contiguous area can petition a county planning commission to zone the area for farming purposes or that planning commissioners can call a meeting to initiate such a move. As matters now stand farm lands have no protection. If engulfed in withdrawal of land for residences or industry needs, the remaining farm lands can face the problems of increased taxes because homes, factories, airports, etc., can afford to pay higher taxes since the land involved per home or factory is a minor part of the investment. With farms, the reverse is true — the land is by far the greatest part of any investment in farms.

For example, a million-dollar factory can have $50,000 invested in 10 acres of land, or but 5 percent in land. A farm representing an investment of $100,000 can have $20,000 in buildings and $80,000 in 80 acres of land, or 80 percent in land and 20 percent in buildings. One case is the reverse of the other. And, if both farm lands and factory lands are taxed equally at 5 per cent of the market value and at an assessment rate of $5, the million-dollar factory pays a land tax of $1,250, the farm a similar tax of $2,000. Of course, the tax on improvements is something else again. And again the factory assessment and rate may be applied to farm lands with a higher and distinctly unjustifiable tax rate.

What lessons are to be found in all this? I would say the first step is a canvass of every county where proposals are in sight regarding new roads or highways, future air fields, new government withdrawals for parks, monuments, defense needs, residential sites, etc. Proposed withdrawals should then be studied in the light of possible effect upon prevailing agricultural lands. The answer then is to be sought to the question: Are the proposed sites the only or best ones available for the proposed project, or can alternative sites be found which will satisfactorily serve the purpose of the project and yet be so relocated that only a minimum of — or better, *no* — good farming land shall be lost to production.

Grassed Waterways

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Criteria for Their Design, Construction, Establishment, and Maintenance

PRINCIPLES of design are as applicable to grassed waterways as they are to many familiar engineering structures.

Natural drainageways on cultivated land were once protected by native vegetation. This dense cover of vegetation gave enough protection to prevent severe erosion and the formation of gullies, although the channels of drainageways in the upper reaches of watersheds are steep in comparison with main watercourses. When the native sod was plowed, little thought was given to the effect this change would have on the drainage systems of farm land. Consequently many drainageways are now eroding large gullies that have gradually branched out and dissected farms into numerous small, irregular fields.

The establishment of vegetated outlets to stabilize these channels is one of the initial practices that must be applied before some other practices of a conservation program, such as terracing, can be applied. More failures of terrace systems are attributed to improper design and inadequate vegetative protection of the outlets than to any other cause. There are criteria for the design, construction, establishment and maintenance of vegetated waterways which are particularly pertinent to this type of construction. Adherence to these criteria during the establishment of vegetated waterways is essential to their successful functioning.

For the discussion of the design, establishment and maintenance of a grassed waterway, the following water-disposal problem has been selected. The conditions here are representative of many of the conditions found in southeastern Nebraska. The procedure is applicable to other locations, with adjustments in criteria to meet local conditions.

Given:

Runoff Data

- Drainage area—40 acres of cultivated land to be terraced
- Location — Southeastern Nebraska
- Annual rainfall — 30-in average
- Runoff — Maximum peak rate, 2½ iph

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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Waterway Data

- Slopes — 2 to 6 per cent (See profile Fig. 1)
- Soils — Loess and glacial till (See profile Fig. 2)
- Velocity — Allowable velocity, 5 fps
- Side Slopes — Maximum steepness — 4 to 1
- Retardance factor — *D* (See USDA SCS-TP-61)

Determine:

- Required depths and cross sections of channels
- Additional structures or practices
- Kinds of vegetative cover to be established.

The depths of flow and channel cross sections of the waterway for the various slopes and reaches, which are shown on the profile in Fig. 1, can be determined readily from tables. The tables are calculated from data given in the publication, entitled "Handbook of Channel Design for Soil and Water Conservation" (USDA-SCS-TP-61). This reference covers data developed by the Stillwater (Okla.) Outdoor Hydraulic Laboratory. The calculated channel depths are increased by 0.4 ft to compensate for the added resistance caused by the grass before mowing, or when it has grown tall.

The design data for the channels are shown in the Table 1 and Fig. 1 for the conditions found at critical points of erosion along the waterway. Channel No. 1 (see plan and profile) is made with a 20-ft bottom width from Station 0+00 to Station 9+80 for the entire length of the waterway. Design flow calculations would permit narrower widths toward the upper end, but it is impractical in field construction to make numerous changes in channel widths.

A channel depth of 1.0 ft is provided from station 0 + 00 to station 8+00 and 1.1 ft from station 8+00 to 9+80.

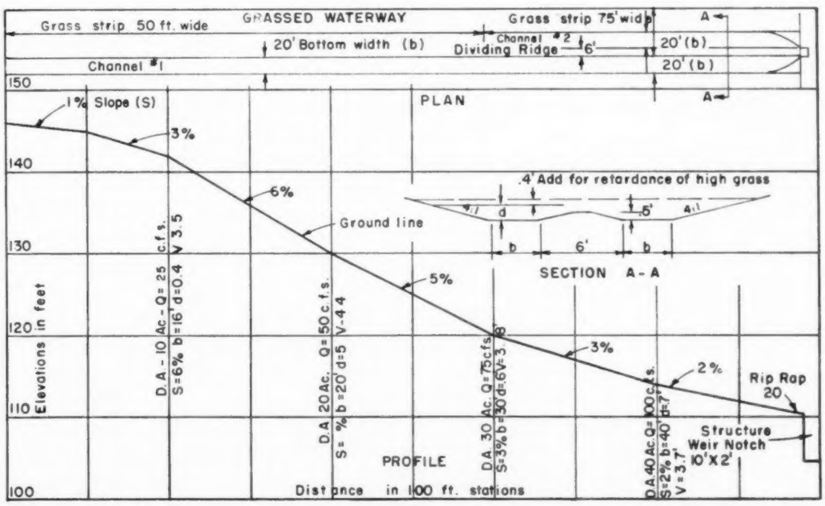


Fig. 1 Plan profile and typical cross section of grassed waterway

TABLE 1. DESIGN DATA FOR SIZES OF CHANNELS

Station	DA	Runoff	S	b	V	d	Channel Capacity
	acres	cfs	%	ft	fps	ft	(Q), cfs
2	10	25	6	16	3.5	0.4	25
4	20	50	5	20	4.4	0.5	49
6	30	75	3	30	3.8	0.6	76
8	40	100	2	40	3.7	0.7	110

DA, drainage area; *S*, slope; *b*, bottom width; *V*, velocity; *d*, depth of channel

CHANNEL QUANTITIES

Channel No.	Station to station	b ft	Side slope	d ft
1	0−8+00	20	4 to 1	1.0
1	8−9+80	20	4 to 1	1.1
2	6−8+00	20	4 to 1	1.0
2	8−9+80	20	4 to 1	1.1

Channel 2, which parallels channel 1, is made with a 20-ft bottom width and is added from station 6 + 00 to station 9+80 to carry additional flow between these stations. The channel depth is 1.0 ft from station 6+00 to station 8+00 and 1.1 foot from station 8+00 to station 9+80.

Channels 1 and 2 are separated by a low dividing ridge 6 ft wide at the base and 0.5 ft high to prevent meandering and the concentration of flow in case of the failure of the grass cover in some spot. The channel dividing ridge is made low and flat enough to permit easy crossing with haying and other equipment.

Too great refinement in caluculations of flow and channel sizes is rarely justified in field practice. Nevertheless failure of the channel is invited if recommended safe velocities, as determined from experimental data, are exceeded too far. In practice the design of some grassed waterways can be determined by inspection. Some require the use of a slope level and paced distances. Some call for the use of an engineer's level and stadia or taped distances. Drainage areas are usually determined from aerial photographs.

At the lower end of the grassed waterway used in this problem an overfall structure with a 10 x 2-ft weir notch is needed to drop the water safely to a stable outlet. Riprap 20 ft wide protects the channel from scour at the entrance to the weir notch of the drop structure. Either reed canary grass may be seeded or prairie cord grass may be spot sodded at the edges of the riprap. Roots and rhizomes of the grass soon bind the riprap material together, and the edges of the structure will be protected by a heavy mat of vegetation.

Grassed waterways are designed for velocities of flow that are safe for the cover the site will support. It is essential for waterway stability, therefore, that an adequate cover be established and maintained. If the vegetative cover fails, gully erosion occurs because bare ground erodes under such velocities of flow.

CONSTRUCTION OF THE WATERWAY

Channels are shaped to the dimensions shown in Fig. 1. Available topsoil is saved and replaced where it is lacking. Waterways that require shaping are built with ordinary earth-moving machinery.

Temporary dikes about 1 ft high are built on each side of the waterway to exclude runoff water until a sod has become established. Outside the temporary dikes an area 20 ft wide is heavily seeded to a close-growing temporary crop to reduce erosion. It may be small grain, oats, sorghum, corn, Sudan grass, millet, or any suitable fast-growing crop to provide a dense temporary cover. When the perennial vegetation is well established, the dikes are removed and the surface smoothed to permit water to run into the grassed waterway.

A heavy subsoil layer occurs at station 3 + 50, which creates a wet condition. Here, to correct this condition, a 5-in tile drain is laid to accurate line and grade, and staked in the field. The tile line is carried to an outlet away from the waterway. The outlet end of the tile is provided with a section of metal pipe 6 to 8 ft long for protection. A flap gate is used at the outlet of the metal section to exclude rodents.

The overfall structure at the end of the waterway is built according to a standard plan. Line and grade are given on field stakes.

ESTABLISHING THE VEGETATION

There are a number of factors to be considered in the establishment of an adequate vegetative cover. Some of these are shown in Fig. 2. The soil must be suitable for the growth of vegetation, or it must be properly conditioned.

Between station 0 and station 3 in Fig. 2, the soil is deep, friable, well-drained loess. Brome grass and alfalfa will be established in this area, as the loess soil is favorable for their growth. This grass-legume combination is a desir-

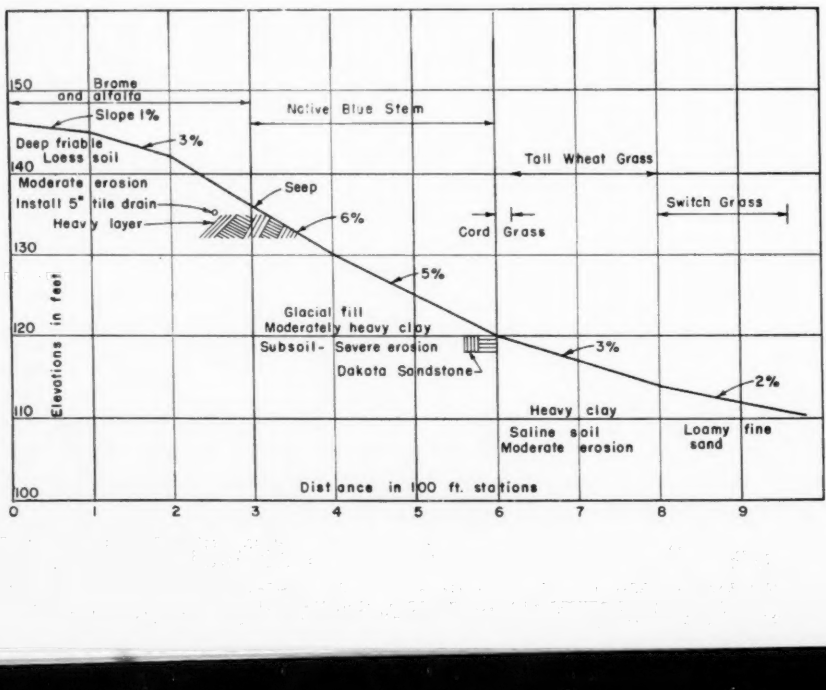


Fig. 2 Profile showing soil characteristics and adapted grasses

able crop for the farmer. Grasses should make up the major part of the mixture, while legumes, if used, become only a minor part. Whenever there is a rhizomatous grass that is adapted to the site, it should be included.

Just below station 3 is a seepy area which is caused by the outcropping of the impervious clay layer shown on the profile. It was decided to tile this area to drain the soil so that desirable upland vegetation, such as brome and alfalfa, will grow. This outcropping exposes some sterile subsoil between station 3+20 and 3+60. This will be backfilled with topsoil to provide a better site for growing an adequate cover.

The soil between stations 3 + 60 and 6 is glacial till. It is only moderately fertile. A native bluestem mixture will be seeded as the most suitable vegetation for this segment. It will maintain vigorous sod on this soil of low fertility and will require very little maintenance. In order to have fewer grasses to seed and harvest, the bluestem mixture may be seeded on all of the upper 600 ft of the waterway.

A seepy area also occurs just below station 6 + 00. It is caused by an underlying layer of Dakota sandstone. Since it is impractical to tile drain, a grass that is adapted to wet soil will be established. This may be a rhizomatous grass such as prairie cord grass which can be spot sodded since there is a source of sod in a meadow below this waterway. Reed canary grass and alsike clover are also adapted to this site.

Between station 6 + 20 and 8, the soil is a wet, heavy, saline clay. This area will be seeded to tall wheat grass. This is one of the most desirable grasses that will grow on wet, salty sites. Although it is not rhizomatous, a dense growth of tall wheat grass will control erosion on this gentle grade.

Between stations 8 and 9 + 80, the soil is a loamy fine sand of low fertility. It will be seeded to switch grass, which is best adapated to this soil. Switch grass provides good forage.

In the foregoing selection of vegetation for the various sites, it is recognized that not all species thrive equally well under all conditions, nor do all species form a dense sod. For example, if brome grass were seeded in the wet area at station 6 it would likely drown, or not grow vigorously enough to form a satisfactory sod. But reed canary grass and tall wheat grass are well adapted to wet sites and will provide the good sod needed to carry running water.

SEEDBED PREPARATION

A well-prepared seedbed for the vegetated waterway is one that is fine, firm, moist and free of growing weeds and objectionable debris. If a seedbed is not properly prepared, the sod obtained is likely to be rough, spotty, thin and weedy. It will be difficult to maintain, or the grass may even fail before becoming established.

The smoothness of the waterway will be checked before preparing the seedbed. Necessary fine levelling, floating or dragging will be done. All operations of seedbed preparation will be done when the heavy soil is dry enough not to cause puddling or baking. Chances of poor, irregular seedling emergence are thus reduced.

Traveling of heavy equipment during construction operations may compact the soil severely. The structure of the heavy soil, such as between stations 2 and 7, is frequently very poor. Perhaps it will be destroyed during construction, especially if moisture conditions are too wet when it is done. If this condition exists, shallow plowing or frequent heavy disking will be necessary to get sufficient fine soil to cover the seed. Disking, harrowing, and packing or rolling will usually provide the desired fine, firm seedbed. Perform these operations with little delay between them. This may reduce the loss through evaporation of the surface moisture that is needed for rapid emergence of seedlings.

ESTABLISHING THE VEGETATION

The problems of establishing the outlet will be minimized by carrying out the following procedures:

1 Lime the soil, if necessary, and apply the needed fertilizer.

2 Seed or sod at the proper rate, depth, and time for the species used. The seeding rate will be twice that of usual pasture seedings.

3 Provide a cover of annual crop stubble or mulch to control erosion. Mulching with a ton per acre of native hay that contains viable seed is a good method of establishing native bluestem. Other suitable mulches include straw, hay, manure, corncobs, etc., applied at 3 to 5 tons dry weight per acre.

4 Control competitive weed growth. Mow at a height that does not clip the seedlings while cutting the taller and faster growing weeds.

5 Use insecticides and control rodents when the infestation is first noticed.

6 Frequently inspect seeding and immediately repair breaks.

7 Protect the waterway from damage by livestock trampling and grazing.

WATERWAY MAINTENANCE

A good maintenance program prevents the need for many major repairs of the sod. Timely and proper mowing increases density and vigor of the turf, retards weed growth, prevents weed seed formation and develops a tougher sod.

Fertilizing is a recurring maintenance operation. The brome grass and tall wheat grass, which are cool-season grasses, should have approximately 50 to 60 lb of available nitrogen per year either in commercial fertilizer or heavy applications of manure. Half of the commercial nitrogen fertilizer should be applied just ahead of the seasons in which most of the growth of the particular species takes place.

Inspect the waterway at frequent intervals for breaks in sod and the need for maintenance of the structure. Sod rills or fill with good soil, reseed, and firmly pack. This usually heals the break before it becomes large. However, well-packed sod is less apt to wash away if an intense rain falls soon after repairing the rill. Sodding may be done with an ordinary shovel or labor may be saved with a tractor-operated hydroscoop.

Vegetated waterways represent an investment of capital and, like all mechanical practices, call for timely maintenance if they are to function satisfactorily.

INSTRUMENT NEWS

KARL NORRIS, Editor

Sponsored by the ASAE Committee on Instrumentation and Controls. Contributions on agricultural applications of instruments and controls and related problems are invited, and should be submitted direct to K. H. Norris, Agricultural Research Center, Beltsville, Md.

Measuring Air Flow with Perforated Metal Sheet

Claude K. Shedd
Life Fellow ASAE

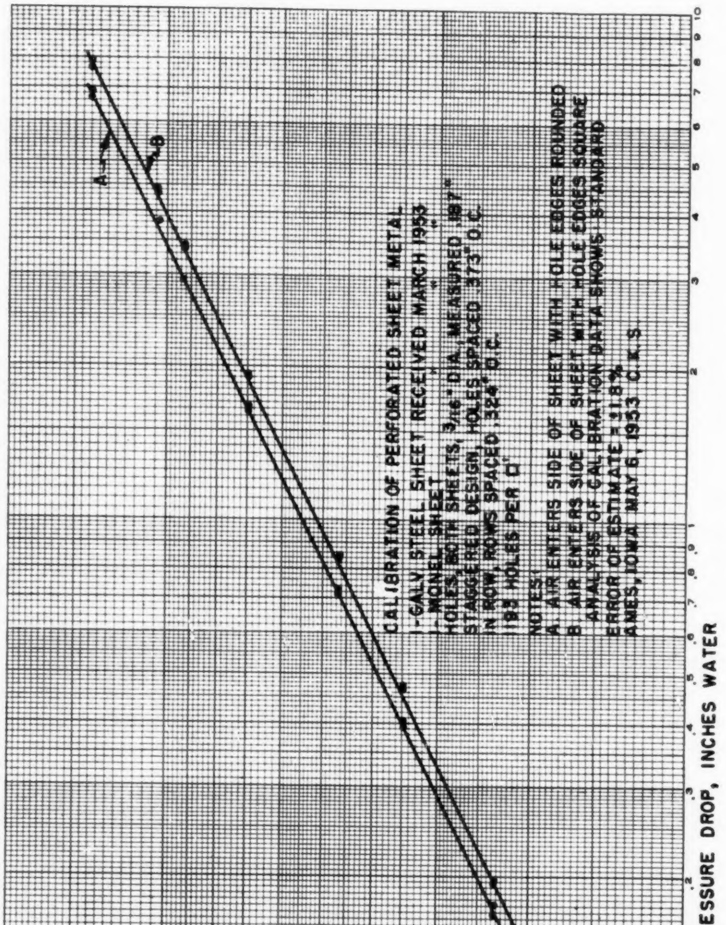
MULTIPLE orifices made from commercial perforated sheet metal have been used for measuring low rates of air flow during the past six years on the USDA grain storage research project in cooperation with the Iowa Agricultural Experiment Station at Ames, Iowa. A sheet of perforated metal to be used for orifice plates is calibrated by cutting two small sample plates from opposite corners of the sheet. These two sample plates are calibrated for air flow per hole at various pressure drops by use of the displacement apparatus that was described in an article entitled "Some New Data on Resistance of Grains to Air Flow" published in the September, 1951, issue of AGRICULTURAL ENGINEERING (vol. 32). Calibration of two sheets received in March, 1953, is shown in the graph on this page. When material from these sheets is used for air-volume measurement, this chart is used to determine the number of holes to be exposed to air flow to give the desired air volume. The chart is used also to determine the actual volume of flow after the experiment is in operation and the pressure drop has been measured.

The general accuracy of measurement by this method is indicated by the following. The data plotted in the graph are from 144 air flow tests of four sample plates from two sheets of metal. The readings from the four sample plates from the two sheets were near enough alike that one line is drawn for both the monel metal and the galvanized sheet. Statistical analysis of the results showed standard error of estimate of ± 1.8 percent. With 30 holes in a plate exposed, the pressure drop for a given rate of flow per hole was about 1 percent less than with 10 holes exposed. This was too small a difference to show by separate lines in the graph.

Holes in these sheets had been formed by punching, and consequently the edge of the hole was slightly rounded on one side of the sheet, square on the other side. When air entered from the square-edge side, the pressure drop for a given rate of air flow was about 14 percent greater than when flow was in the opposite direction. This is shown by the two graph lines, A and B. There was less variation in data obtained with flow entering from the square-edge side, and therefore it is generally best to provide for air flow in this direction.

This paper was prepared expressly for AGRICULTURAL ENGINEERING, and is approved as Journal Paper No. J-2491 of the Iowa Agricultural Experiment Station, Ames, Project No. 587 (USDA cooperating).

The author—CLAUDE K. SHEDD—is senior agricultural engineer, farm buildings section, agricultural engineering research branch, U.S. Department of Agriculture.



PROPOSED ASAE CODE:

Testing and Rating Crop-Drying Equipment

To ASAE MEMBERS:

The accompanying proposed official ASAE code is sponsored by the ASAE Committee on Crop Drying Equipment—A. M. Einerson (chairman), S. S. DeForest, L. L. Hamilton, B. P. Hess, R. E. Heston, L. E. Holman, W. V. Hukill, Nolan Mitchell, J. B. Moore, Jr., J. W. Weaver, Jr., and F. J. Zink. It is a revised edition of the official code adopted by the Crop Dryer Manufacturers Assn. and presently being used by several manufacturers of crop-drying equipment.

This publication of the proposed code is intended to provide an opportunity for interested ASAE members to review it critically and to offer the Committee such recommendations for revisions or additions as they may wish. It is suggested that such comments be addressed to the Committee chairman: A. M. Einerson, 199 Rhein St., Mansfield, Ohio.

Action by the Society to adopt the proposal as an official ASAE code will not be consummated until Society members have had adequate opportunity to express their views to the Committee.

1.0 PURPOSE

1.1 This Code is intended to provide a uniform and standardized method of testing and rating crop-drying equipment.

2.0 SCOPE

2.1 The Code covers equipment having fans for forced air circulation and a heat output of less than 2,000,000 Btu per hour.

3.0 DEFINITIONS

3.1 *Crop Conditioner.* A device for forcing heated or unheated air through a grain or forage crop for the purpose of conditioning it. In the case of heated air, the heat is generated by the combustion of fuel within the device.

3.2 *Crop Conditioning.* The process of changing the moisture content of a grain or forage crop by the means of forcing heated or unheated air through it.

3.3 *Heat Exchanger.* A gastight chamber in which fuel is burned, plus a secondary heat-transfer section through which the gases of combustion flow.

3.4 *Indirect Fired.* In an indirect-fired drier the combustion takes place within a heat exchanger and the products of combustion are exhausted to the atmosphere through a stack or flue. Heat is transferred to the drying air stream through the surfaces of the container.

3.5 *Direct Fired.* In a direct-fired drier the products of combustion and the heat of combustion are given directly to the drying air stream.

3.6 *Heat Input.* The total gross heating value of the fuel supplied to the crop drier for combustion expressed in Btu per hour.

3.7 *Heat Output.* The heat transferred to the discharge air stream as measured in Btu per hour at maximum heat input and fan delivery.

3.8 *Heat Exchanger Efficiency.* 100 percent times the percentage of the heat output divided by the heat input.

3.9 *Casing.* The outer enclosure surrounding the entire heat exchanger and confining the air being heated.

3.10 *Steady State.* The point where the operation of the crop drier reaches equilibrium.

4.0 REQUIREMENTS FOR TESTING AND RATING

4.1 Accessories. All wire guards, screens, and accessories shall be in place during the test.

4.2 Motor Ratings. A calibrated motor shall be used for the purpose of testing.

4.3 Maximum heat exchanger or combustion enclosure surface temperature:

(A) If the combustion chamber is built of low-carbon steel or gray-iron castings, the temperature of the hottest part of the metal surface serving as heat exchanger or combustion enclosure shall not exceed that of the inlet air by more than 930 F measured by thermocouples attached to the surface.

(B) Higher spot temperature (published scaling temperature less 100 F) may be permitted when a higher heat-resisting steel or casting is used (Table 1). The type of material and its published scaling temperature is to be shown in the test report. If the material used is not listed on Table 1, the manufacturer must report type of material and its scaling temperature.

4.4 Any of the following fuels may be used for the test:

(A) OIL. The API gravity shall be determined and the value for heat content taken from Table 2.

(B) GAS. Natural gas having a Btu content of approximately 1000 Btu per cu ft and a specific gravity of approximately 0.60.

(C) LP GAS. Propane, butane, or a mixture of these two gases may be used. Percentage of mixture must be reported.

(D) SOLID FUELS. A complete fuel analysis must be reported.

5.0 METHOD OF TESTING CROP-CONDITIONING EQUIPMENT

5.1 *Test Readings.* The duration of the test shall be at least 20 min after reaching steady state at each increment of static pressure against the fan. The increments of pressure against the crop conditioner discharge will be ½ in w.c. and

TABLE 1. SCALING TEMPERATURE OF ALLOY AND STAINLESS STEELS*

Type	Scaling temperature	Type	Scaling temperature	Type	Scaling temperature
302	1600	316	1650	416	1250
303	1600	321	1600	430	1500
309	2000	347	1600	446	1900
310	2000	410	1250		

Table VII, page 556, "Metals Handbook," 1948 edition.

range from free delivery to static no discharge. There will be no heat input or output at static no discharge since this is a measurement of fan characteristic only. Three complete sets of test readings shall be taken at 10-min intervals (minimum) during steady state operation and shall consist of the following measurements:

5.11 *Stack Temperature Readings.* Stack temperature shall be an average of at least three readings taken at the discharge of a 90 deg elbow. The elbow shall be connected to the stack within 1 ft 0 in of the outer casing and shall be of the same diameter as the stack and of one diameter radius. The readings shall be taken at equally spaced positions on a vertical diameter of the discharge opening of the elbow.

5.12 *Heat Exchanger Surface Temperature Measurements.* Surface temperature shall be measured by at least 10 thermocouples brazed, tack welded, or metal screwed approximately 1 ft 0 in apart to the hottest sections of the combustion chamber. A potentiometer shall be used to determine the thermocouple temperature. If the surface is visibly red with heat, a calibrated pyrometer may be used to determine the surface temperature. At least ten readings shall be taken approximtely 1 ft 0 in apart at the hottest sections of the combustion chamber.

5.13 *Fan Characteristics.* The air characteristics of the entire assembled crop conditioner, including fan at each one-half-inch increment of static pressure, shall be determined in accord with the latest edition of the Standard Test Code for Centrifugal and Axial Fans published by the National Association of Fan Manufacturers. For purposes of this test, the entire crop conditioner, including fan and other component parts, shall be substituted for the fans in the Standard Test Code Procedure. A copy of the Log Sheet Traverse Readings (Plate XIV) and Log Sheet Summary (Plate XV) shall be submitted with the necessary data and calculations completed. The required measurements are as follows:

(A) *Air Volume.* Air volume at each one-half-inch increment of static pressure shall be determined by use of a test duct and standard pitot tube as illustrated in Plate I or VII and Plate IX of the NAFM code.

(B) *Air Temperatures*

(1) The inlet air temperatures must be recorded at each steady state. Readings must be taken near the air inlet of the crop conditioner.

(2) The average outlet air temperatures shall also be checked and recorded. Readings by thermocouples are to be taken in each 36-sq-in segment of the test duct or at the location of the pilot tube reading points. The thermocouples shall be located at a minimum distance of 7½ diameters from the entrance to the test duct. Heat loss from the test duct shall be calculated in accordance with the current issue of the ASHVE Heating, Ventilating and Air Conditioning Guide.

(C) *Static Pressure.* The static pressure shall be determined and adjusted as in the NAFM code and shall be increased in ½-in w.c. increments from 0-in w.c. to static no discharge, and test readings shall be taken at steady state at each increment of pressure.

TABLE 2. CALORIFIC VALUES FOR FUEL OIL*

Degrees API at 60 F	Density, lb per gal	Btu per lb	Btu per gal
24	7.587	19,190	145,600
25	7.538	19,230	145,000
26	7.490	19,270	144,300
27	7.443	19,310	143,700
28	7.396	19,350	143,100
29	7.350	19,380	142,500
30	7.305	19,420	141,800
31	7.260	19,450	141,200
32	7.215	19,490	140,600
33	7.171	19,520	140,000
34	7.128	19,560	139,400
35	7.085	19,590	138,800
36	7.043	19,620	138,200
37	7.011	19,650	137,600
38	6.960	19,680	137,000
39	6.920	19,720	136,400
40	6.879	19,750	135,800
41	6.839	19,780	135,200
42	6.799	19,810	134,700

*Data from National Bureau of Standards Miscellaneous Publication M97 (table 6).

TABLE 3. CORRECTION TO STANDARD API GRAVITY AT 60 F*

Observed temp. of oil, deg F	24	25	26	27	28	29	30	31	32	33
50	24.6	25.6	26.6	27.6	28.7	29.7	30.7	31.7	32.7	33.7
60	24.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	32.0	33.0
70	23.4	24.4	25.4	26.4	27.4	28.3	29.3	30.3	31.3	32.3
80	22.8	23.8	24.8	25.7	26.7	27.7	28.7	29.6	30.6	31.6
90	22.2	23.2	24.2	25.1	26.1	27.1	28.0	29.0	30.0	30.9
100	21.6	22.6	23.6	24.5	25.5	26.5	27.4	28.4	29.3	30.3

Observed temp. of oil, deg F	34	35	36	37	38	39	40	41	42
50	34.7	35.7	36.7	37.7	38.8	39.8	40.8	41.8	42.8
60	34.0	35.0	36.0	37.0	38.0	39.0	40.0	41.0	42.0
70	33.3	34.3	35.3	36.2	37.2	38.2	39.2	40.2	41.2
80	32.6	33.6	34.6	35.5	36.5	37.5	38.4	39.4	40.4
90	31.9	32.9	33.8	34.8	35.8	36.7	37.7	38.7	39.6
1000	31.3	32.2	33.2	34.1	35.1	36.1	37.0	37.9	38.9

*Data from National Standard Petroleum Oil Table, NBS Circular C410 (March 4, 1936).

Standard Method of Rating Crop-Conditioning Equipment Using Heated or Unheated Air with Fans for Forced-Air Circulation

Data

Type drier ....

Type heat exchanger............

Type fuel ....

Maximum heat input............Btu per hr

Maximum heat output............Btu per hr

Operating Characteristics

External static pressure, inches, w.c.	Fan delivery of standard air, cfm	Power bhp	Temperature rise through drying equipment, deg F	Heat exchanger efficiency, percent
0 . . .	......	......	......	......
½ . . .	......	......	......	......
1 . . .	......	......	......	......
1½ . . .	......	......	......	......
2 . . .	......	......	......	......
2½ . . .	......	......	......	......
3 . . .	......	......	......	......
3½ . . .	......	......	......	......

5.14 *Measurement of Fuel.*

(A) If oil is the fuel being burned, an accurate scale or calibrated burette shall be used to weigh the fuel oil during the test. The fuel supply lines shall be suspended free of the fuel container.

(B) If gas is the test fuel, a calibrated test meter must be used.

(C) If LP gas is the test fuel, either the weight or flow method may be used.

(D) If a solid fuel is the test fuel, the weight method must be used.

5.15 *Data on Main Supply Fan and Motor Driving Fan*

(A) The speed (rpm) of the fan assembly and motor driving fan is to be measured with a suitable speed counter. Tachometer readings will not be acceptable unless the instrument has been calibrated and the corrections reported with the readings.

(B) The voltage and amperage being supplied to the motor driving the fan is to be measured with calibrated meters so that the actual brake horsepower may be determined at each steady state.

5.16 *Fuel Pressure.* The pressure of the fuel being supplied the burner must be measured with a suitable gage at a point between the fuel shutoff valve and burner nozzle.

5.17 The following test data and readings must be obtained and recorded:

DATA ON EQUIPMENT

1. Report of test on crop conditioner model ....
2. Manufactured by ....
3. Location of test ....
4. Date of test ....
5. Duration of test .... hr
6. Fuel-burning equipment
   - 6.1 Type ....
   - 6.2 Type ignition ....
   - 6.3 Fuel oil nozzle data
     - 6.31 Make ....
     - 6.32 Rating .... gph
     - 6.33 Spray angle .... deg
   - 6.4 Gas orifice
     - 6.41 Gas orifice size .... diameter
     - 6.42 Number of orifices ....

PHYSICAL DATA

7. Heating surface .... sq ft
   - 7.1 Prime surface .... sq ft
     - 7.11 Combustion chamber proper .... sq ft
     - 7.12 Extended surface affixed to prime surface .... sq ft
   - 7.2 Secondary surface .... sq ft
8. Heat exchanger volume .... cu ft
9. Material of combustion chamber
   - 9.1 If alloy or stainless steel, report the following:
     - 9.11 Type number of material ....
     - 9.12 Published scaling temperature .... deg F
10. Physical properties of fuel (Commercial Standards No. 2 fuel oil is to be used whenever possible.)
    - 10.1 Fuel oil ....
      - 10.11 Gross heating value .... Btu per gal
      - 10.12 Gross heating value .... Btu per lb
      - 10.13 Viscosity SSU at 100 deg F ....
      - 10.14 API gravity at 60 deg F ....
      - 10.15 Flash point .... deg F
      - 10.16 Fire point .... deg F
      - 10.17 Pounds fuel per gallon ....
    - 10.2 Gas
      - 10.21 Gross heating value per cubic foot ....
      - 10.22 Specific gravity ....
    - 10.3 Type of solid fuel
      - 10.31 Gross heating value .... Btu per lb
      - 10.32 Fuel analysis
        - (a) Moisture .... percent
        - (b) Volatile matter .... percent
        - (c) Fixed carbon .... percent
        - (d) Ash .... percent
        - (e) Sulphur .... percent
        - (f) Hydrogen .... percent
        - (g) Carbon .... percent
        - (h) Oxygen .... percent
11. Motor Data
    - 11.1 Motor nameplate data of calibrated motor at full load
      - 11.11 Voltage .... volts
      - 11.12 Amperage .... amps
      - 11.13 Horsepower .... hp
      - 11.14 Speed at full load .... rpm
      - 11.15 A duplicate of the calibrated motor curves must be forwarded with the test data and results.
12. Fan and Blower Data
    - 12.1 Manufactured by ....
    - 12.2 Model ....
    - 12.3 Wheel diameter ....
    - 12.4 Outlet diameter ....
    - 12.5 Type ....

Data Sheet

Readings taken every ..... minutes after steady state has been reached.
Readings at .... inches w.c. static pressure.

		1	2	3	4
	Date				
13.	Time of readings	Time X	X+	X+	Avg hr
14.	Weight in pounds or cubic feet of fuel	.....	.....	.....	.....
15	Accumulated weight in pounds or cubic feet . .	.....	.....	.....	.....
16.	Pressure of fuel at burner	.....	.....	.....	.....
17.	Stack temperature, deg F	.....	.....	.....	.....
18.	Air temperature inlet to conditioner, deg F . . .	.....	.....	.....	.....
19.	Average air temperature discharge duct, deg F . .	.....	.....	.....	.....
20.	Volume of standard air, cfm				
21.	Motor data				
	21.1 Data as read				
	21.11 Volts . .	.....	.....	.....	.....
	21.12 Amperes .	.....	.....	.....	.....
	21.13 Speed (rpm)	.....	.....	.....	.....
	21.14 Horsepower	.....	.....	.....	.....
22.	Speed of fan (rpm) . .	.....	.....	.....	.....
23.	Heating surface temperature and locations	.....	.....	.....	.....
	23.1	.....	.....	.....	.....
	23.2	.....	.....	.....	.....
	23.3	.....	.....	.....	.....
	23.4	.....	.....	.....	.....
	23.5	.....	.....	.....	.....
	23.6	.....	.....	.....	.....
	23.7	.....	.....	.....	.....
	23.8	.....	.....	.....	.....
	23.9	.....	.....	.....	.....
	23.10	.....	.....	.....	.....

Calculated Values

24. Actual power used by crop conditioner = brake horsepower (bhp) from calibrated motor curve.
25. Air temperature (deg F) rise over unit = item 19 − item 18.
26. Btu input per hour = item 15 × item 10.12, or item 10.31.
27. Btu output per hour = item 25 × item 20 ÷ 0.917.
28. Btu release per cubic foot of heat exchanger volume = item 27 ÷ item 8.
29. Efficiency of heat exchanger (in percent) = item 27 × 100 ÷ item 26.

NEWS SECTION

Marshall New Va. Section Chairman

McNEIL MARSHALL, associate agricultural engineer, Virginia Agricultural Experiment Station, was elected chairman of the Virginia Section of the American Society of Agricultural Engineers at the Section meeting held at Natural Bridge, Va., May 1. He succeeds U. F. Earp, a member of the agricultural engineering staff of Virginia Polytechnic Institute.

Three new vice-chairmen were elected at this meeting: James M. Stanley, associate agricultural engineer, USDA, stationed at VPI; Phelps Walker, drainage engineer, and P. W. Stoneburner, sales engineer, Atlantic Aluminum Co., Waynesboro.

The new secretary of the Section is V. H. Baker, a member of the VPI agricultural engineering staff. He succeeds McNeil Marshall.

A special feature of the meeting, in addition to the regular program of technical papers, was the presentation of a certificate of appreciation to Charles E. Seitz honoring him for his contributions to agricultural engineering both in the state of Virginia and nationally. Mr. Seitz retired recently as head of the agricultural engineering department of Virginia Polytechnic Institute, which department he helped organize in 1922 and which he headed until his retirement. Mr. Seitz became a member of ASAE in 1917 and some years ago was honored by the Society with the elevation of his grade of membership to that of Fellow. He served the Society as chairman of its College Division in 1931-32 and as President in 1932-33. The Society honored him with the award of the Cyrus Hall McCormick Gold Medal in 1951.

(Left to right) U. F. Earp, retiring chairman, Virginia Section, ASAE; McNeil Marshall, new chairman of the Section for the ensuing year; J. M. Stanley and Phelps Walker, newly elected vice-chairman. P. W. Stoneburner and V. H. Baker, newly elected vice-chairman and secretary, respectively, were not present when the picture was taken

ASAE Meetings Calendar

June 20-23—47TH ANNUAL MEETING, University of Minnesota, Minneapolis

August 24-26—NORTH ATLANTIC SECTION, University of Vermont, Burlington

October 14 and 15—PACIFIC NORTHWEST SECTION, Davenport Hotel, Spokane, Wash.

December 6-8 — WINTER MEETING, Edgewater Beach Hotel, Chicago.

February 7-9—SOUTHEAST SECTION, Louisville, Ky.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Mich. Section Elects Pfundstein

IN AN election conducted by letter ballot of its members, the Michigan Section of the American Society of Agricultural Engineers recently elected K. L. Pfundstein, manager, agricultural engineering division, Ethyl Corporation, as the new chairman of the Section for the 1954-55 year. He succeeds W. G. Buchinger, farm service engineer, The Detroit Edison Co.

Three new vice-chairmen of the Section were also elected: E. D. Anderson, director, agricultural extension department, Stran-Steel Division, Great Lakes Steel Corp.; H. M. Gitlin, research engineering division, Tractor and Implement Division, Ford Motor Co., and Carl W. Hall, associate professor of agricultural engineering, Michigan State College.

The new secretary-treasurer of the Section is R. L. Maddex, extension agricultural engineer, Michigan State College, and the new Nominating Committee consists of Chris Nyberg (chairman), C. B. Richey, and W. H. Sheldon.

The above-named officers took office following the Section's spring meeting on May 8.

Group in attendance at the ASAE Michigan Section meeting held May 8 in the agricultural engineering building on the Michigan State College campus at East Lansing

Ohio Section Meets at Coshocton

ON MAY 15 the Ohio Section of the American Society of Agricultural Engineers held its spring meeting at the research station of the U.S. Soil Conservation Service at Coshocton, Ohio. The forenoon was devoted to an inspection of the equipment for obtaining hydrologic research data at the station, conducted by the station supervisor, Lloyd L. Harrold. This was followed by an inspection of a contour fence experiment conducted by Paul G. Strom, American Steel and Wire Division, U.S. Steel Corp.

The afternoon was given over to a technical program which opened with a talk by Mr. Harrold on a research study of water and the land. Virgil Overholt, agricultural engineer, Ohio State University, talked on the potential irrigated lands of Ohio. He was followed by W. S. Breon, PBF Farm, who talked on his practical experience in field irrigation of potatoes and strawberries. The concluding number on the program was a talk on Ohio's potential water supplies for irrigation domestic use and industry by a representative of the Ohio Department of Natural Resources.

The Ohio Section has issued notice of a joint meeting of the Ohio and Michigan Sections on Nov. 19 and 20 at Columbus.

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NEWS SECTION

(Continued from page 424)

R. M. Section Elects Israelsen

AT ITS yearly meeting in April on the campus of the Colorado A. & M. College at Fort Collins, the Rocky Mountain Section of the American Society of Agricultural Engineers elected Orson W. Israelsen, professor of irrigation and drainage, Utah State Agricultural College, as chairman of the Section for the ensuing year. He succeeds J. W. Borden, vice-president in charge of sales, Eversman Mfg. Co.

The Section also elected as the new vice-chairman, Eldon G. Hanson, head, agricultural engineering department, New Mexico A. & M. College. Norman A. Evans, assistant professors of civil engineering and assistant irrigation engineer, Colorado A. & M. College, was re-elected secretary and treasurer of the Section. S. H. Daines, head, department of agricultural engineering, Utah State Agricultural College, was elected program chairman for the 1955 meeting which will be held on the campus of UAC at Logan.

Group attending ASAE Rocky Mountain Section meeting in April. *(Left to right)* O. W. Monson, Montana State College; J. W. Borden, chairman, Rocky Mountain Section; E. W. Tanquary, president ASAE; D. F. Peterson, head, civil engineering department, Colorado A. & M. College; J. E. Christiansen, dean of engineering, Utah State Agricultural College, and E. G. Hanson, head, agricultural engineering department, New Mexico A. & M. College

A portion of the group of ASAE members and friends attending the meeting of the Society's Rocky Mountain Section at Fort Collins, Colo., April 2 and 3

About sixty members and friends of the Section attended the meeting, the program of which featured a variety of papers devoted to agricultural engineering.

E. W. Tanquary, president of ASAE, was the principal speaker at the Section dinner. As an entertainment feature of the dinner, which proved highly entertaining, was a skit presented by Ivan D. Wood and Guy O. Woodward on how not to present a technical paper.

Chicago Section Meeting at Milwaukee

THE Chicago Section of the American Society of Agricultural Engineers picked Milwaukee for its meeting on May 17. The feature of the meeting was a tour of the plant of the A. O. Smith Corp. in Milwaukee, who manufacture the Harvester silo. Following a program of talks by four members of the A. O. Smith organization, the group toured the plant to witness many interesting phases of the company's manufacturing operations, concluding with a visit to the exhibit hall where the many products made by the company were on display.

PA Section Has a Good Spring Meeting

THE Pennsylvania Section of the American Society of Agricultural Engineers held its spring meeting April 1 and 2 in the Agricultural Engineering Building on the Pennsylvania State University campus with an attendance of nearly 75. The program touched on all phases of agricultural engineering and included timely subjects which created considerable interest among those who attended. The subjects included the latest methods in forage handling, infrared-lamp fire hazards, pole-frame farm buildings, tests on tank milk coolers, side-delivery rakes, a water shed study, and a panel discussion on irrigation. Also a skit showing the value of well-planned motor control was presented. At the conclusion of the program, the group visited Penn State's new dairy barns to inspect types of construction and equipment arrangements used.

At the business session of the meeting, the Section selected Allentown, Pa., as the place for its fall meeting.

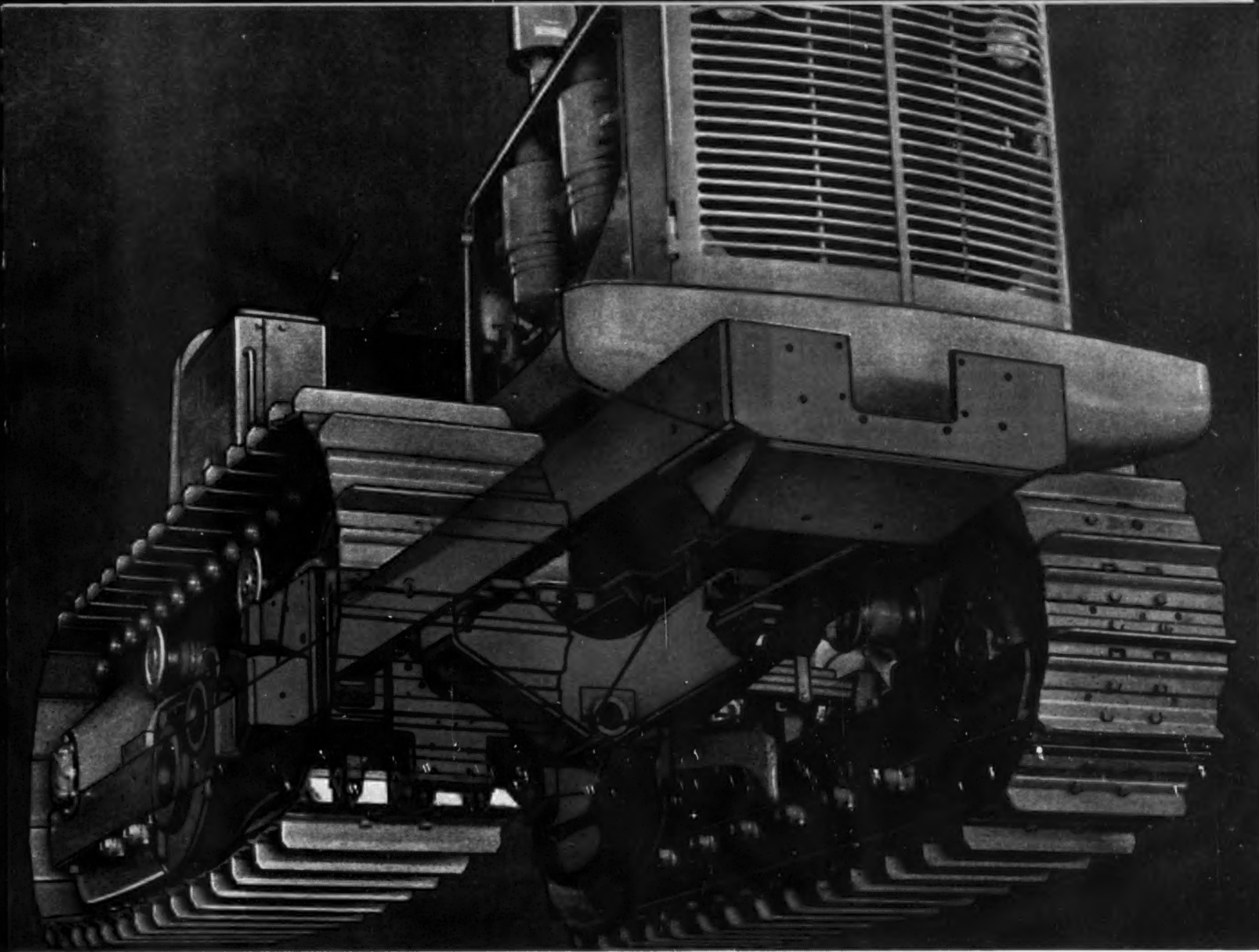
Oklahoma Section Spring Meeting

THE spring meeting of the Oklahoma Section of the American Society of Agricultural Engineers, with over 70 members and friends of the Society in attendance, was held April 29 and 30 at the Sunnyside Home Demonstration Club Building on the Barnitz Creek Watershed at Clinton, Okla.

Following a social get-together on the

(News continued on page 428)

This picture shows members and friends of the ASAE Pennsylvania Section on tour through the new dairy barns on the Penn State campus during the Section meeting in April



NEWS SECTION

(Continued from page 426)

evening of April 29, the program for the forenoon of April 30 opened with a talk on the application of soil mechanics to the design of small earth dams by Ray Means, department of architecture, Oklahoma A. & M. College. He was followed by Homer R. Carlson, territory manager of International Harvester Co., who discussed the subject of earth-moving equipment.

Following luncheon, the afternoon program opened with a paper on the subject of upstream flood prevention by Howard Matson, head of the engineering and watershed planning unit, U.S. Soil Conservation Service, Fort Worth, Tex. Following Mr. Matson's talk, the remainder of the afternoon was devoted to a tour to observe various phases of construction work involved in the building of detention reservoirs on the Barnitz Creek Watershed.

Glenn Beacham of the SCS Flood Prevention Project at Clinton was chairman of the local arrangements committee and was assisted by several of his co-workers, by the Clinton Chamber of Commerce, and by the Sunnyside Home Demonstration Club.

OAC to Have Professional AE Curriculum

FINAL arrangements have been completed for establishing a professional curriculum in agricultural engineering at the Ontario Agricultural College, Guelph, Canada, according to announcement received from C. G. E. Downing, head of the OAC agricultural engineering department. This includes an arrangement with the School of Applied Science and Engineering at the University of Toronto where students will receive their engineering degree, B.A.Sc. This arrangement calls for a five-year program to provide adequate training in agricultural engineering.

Students desiring to enroll in the agricultural engineering curriculum will register at OAC and take the first two years of the course common to all students. In the third year they will enroll in the agricultural engineering option and at the end of the fourth year receive a B.S.A. degree in agricultural engineering. During their four years at Guelph, they will be given all the basic mathematics, physics, biological sciences, and basic engineering courses which qualifies them for registration in the fourth year of engineering at the University of Toronto.

ECPD Survey on Awarding Professional Degrees

THE Recognition Committee of Engineers Council for Professional Development (ECPD) recently completed a survey of the awarding of the professional degree by various engineering educational institutions. A total of 146 questionnaires were mailed, of which 142 were returned.

Of the engineering schools surveyed, 86 award the professional degree while 62 do not. Of the 86 awarding the degree, 74 use professional experience as a basis for awarding the degree, 8 require resident graduate study and 4 include both professional experience and resident graduate study as prerequisites for awarding the professional degree.

Concerning future plans for the professional degree, 69 colleges will continue awarding it, 2 will institute the degree, 13 will abandon it, 49 will continue not to award it, and 17 are uncertain as to future plans. The survey shows that approximately one-fifth of the schools offering the professional degree have either dropped it or are making plans to do so.

The survey also shows an increase of approximately 80 percent in the awarding of professional degrees in the last five years as compared with the previous five-year period. In the last 10 years, 1387 to 1398 professional degrees have been awarded, and of these, 917 to 922 have been awarded during the last five years.

The ECPD Recognition Committee believes the survey to be the most comprehensive of its type ever undertaken and will use it in formulating recommendations on the practice which they believe should be followed in respect to awarding the professional degree as a means of professional recognition of engineers.

All Roads Lead to Minneapolis for the ASAE 47th Annual Meeting June 20-23, 1954

"ALL ROADS LEAD TO MINNEAPOLIS" was the theme of the agricultural engineering students' float (shown in this picture), welcoming members and friends of the American Society of Agricultural Engineers to the Society's annual meeting, June 20 to 23 on the campus of the University of Minnesota at Minneapolis. The float made its appearance in the E (Engineers') Day parade, a traditional celebration of Minnesota's engineering students

NFEC Officer Elections

AT A recent meeting in Chicago of the Steering Committee of the National Farm Electrification Conference, Karl H. Runkle, manager of industry sales, apparatus sales division, General Electric Co., was elected chairman of the Conference for the ensuing year.

Also elected were H. D. Newsom, master of The National Grange, and W. J. Ridout, Jr., editor of "Electricity on the Farm," as vice-chairmen. Russell J. Gingles, farm director of the National Electrical Manufacturers Association, was re-elected secretary. The organization's 8th annual conference will be held in Schenectady, N. Y., on November 11 and 12.

NFEC is an organization of 26 groups having a particular interest in improving living standards and reducing costs through more efficient and economical use of electricity. American Society of Agricultural Engineers is one of its member organizations.

Grassland Committee Activity

DURING this past year the Joint Committee on Grassland Farming, according to its secretary, Z. W. Craine, has published and distributed extensively the "Grassland-Livestock Handbook," and now has in preparation a new booklet "The Economics of Grass Silage."

The Joint Committee is sponsoring a grassland field day at State College, Pa., June 21, in cooperation with American Dairy Science Assn., American Society of Animal Production, and Pennsylvania State University.

This year's annual meeting of the Joint Committee will be in conjunction with a meeting of the Soil Conservation Society of American which will be devoted to a tour in South Georgia and North Florida. The dates are November 12, 13, and 14.

The American Society of Agricultural Engineers is one of the cooperating member organizations of the Joint Committee, on which its official representative is W. C. Krueger, extension agricultural engineer, New Jersey College of Agriculture.

NEWS OF ASAE MEMBERS

Roy B. Gray, head of the Farm Machinery Section of the Agricultural Engineering Research Branch of ARS, retired May 31 after 29 years of service in the U.S. Department of Agriculture.

Roy B. Gray

A native of Iowa, Mr. Gray graduated from Iowa State College in 1909 with a B.S. degree in electrical engineering and obtained a B.S. in agricultural engineering in 1910. He also obtained a professional degree in agricultural engineering in 1931 at his alma mater.

For the period 1910 to 1920, Mr. Gray was associated with the International Harvester Company, conducting experimental work on tractors, which took him to Canada, England, Germany, France, Austria, Rumania, Italy, and South Africa. Included was his work in 1916-17 as head of a tractor assembly depot and a military tractor school in England, and in 1918 as technical advisor to the British Army on agricultural tractors in France and to the Italian Army in Italy.

From 1921 through 1924, Mr. Gray headed the agricultural engineering department of the University of Idaho. He joined the USDA agricultural engineering staff in 1925 and began work on experimental fertilizer placement machinery.

Mr. Gray's first major work in the USDA extended from 1927 to 1931 as a result of the invasion of the European corn borer. In this field he directed borer control work as it involved research and design of machines used in destruction of the pest. This included special plows and flame machines and methods of their use. The control plan called for widespread organization and cooperation between various federal agencies, the states, and Canada.

Mr. Gray was made head of farm machinery and equipment research in 1931 when agricultural engineering was given separate bureau status. In this capacity he directed the work leading to the planning and establishment of the USDA Tillage Laboratory at Auburn, Ala., and the Pest and Plant Disease Control Laboratory at Toledo, Ohio. In addition, he led experimental work in the development of machines for the harvesting and handling of a number of special crops.

During 1936, Mr. Gray spent several months in Europe, observing progress in European farm machinery and farm electrification in seven different countries.

Mr. Gray is the author and co-author of several USDA circulars and bulletins of a technical and semi-technical nature, considerable material for the USDA yearbooks, technical papers and articles for Encyclopedia Britannica.

A member of ASAE since 1920, he was chairman of its Power and Machinery Division in 1933-34 and of the Washington, D.C., section in 1941. He has also served on several technical committees of Farm Chemurgic Council, American Society for Testing Materials, Agricultural Insecticide and Fungicide Association, and farm equipment requirements of the Marshall Plan as an ECA appointee in 1948 to a farm machinery mission to study such needs in ten European countries. He has been a consultant to technical committees of the American Farm Bureau Federation and the American Petroleum Institute. He served in 1942 on the USDA interbureau committee to determine farm machinery needs.

In 1949 Mr. Gray's services to French agriculture were recognized by the French government which conferred on him the decoration of "Officer du Merite Agricole." In 1950 Mr. Gray was awarded the John Deere gold medal by the ASAE for his contributions toward development and progress in agricultural machinery and equipment.

T. Harold Welch has resigned as senior engineer in FHA to become sales manager for C. Starkweather and Son, Inc., lumber dealers and contractors, at Beaver Dam, Wis.

George McConeghy, Jr., recently joined the product engineering department at the McCormick Works of International Harvester Co. He was formerly in the employ of the New Idea Division of Avco Corp., at Coldwater, Ohio.

Joseph F. Schaffhausen, agricultural consultant, announces opening of general offices at Irvington-on-Hudson, N. Y., where a competent staff has been set up to serve the needs of clients in product testing and development, sales management and training, public relations, and all phases of agricultural engineering. Test farms to serve the organization are located in Pennsylvania, Nevada, and Quebec, Canada.

Lowell Stoddard, who has been operating his own tractor sales organization, at Decatur, Ala., is now manager of the Hanna Tractor Co., at Birmingham.

Harry M. Meinert is on leave as junior project engineer at the John Deere Planter Works of Deere & Co. to enter the armed services.

Robert G. Light, who has been employed as a junior engineer of the Oliver Corp., York, Pa., recently resigned having been ordered to active duty with the armed services.

James H. Whitaker, formerly a member of the agricultural engineering staff of the University of Connecticut, some months ago accepted an appointment with the Foreign Agricultural Service, USDA, and was assigned to the Department of Agriculture at Bihar, India. His work at present involves improving the tractor loaning scheme and later it is expected to include some development, promotional and educational work with improved implements for the small farmer.

John H. Zich, formerly manager of the implement sales department, has recently been advanced to chief engineer in charge of harvesting equipment, of the Tractor and Implement Division, Ford Motor Co.

Osgood Murdock, formerly owner and editor of "Western Farm Equipment," published many years under the name "Implement Record," has disposed of his interests in the publication, but continues his duties as secretary of the Tractor and Implement Club of the San Francisco Bay area.

Irvin W. Fahr recently completed a tour of duty in the armed forces, and is now in the engineering department at the John Deere Waterloo Tractor Works.

H. Allen Nitshke is now in the tire development department of the Goodyear Tire and Rubber Co. He was formerly research engineer with the Butler Mfg. Co.

Richard F. Dudley has resigned as assistant agricultural engineer, Mississippi Agricultural Experiment Station, to engage in business with the Mount Ulla Flour Mills, Inc., at Mount Ulla, N. C.

Max H. Ririe, formerly project engineer, Niagara Chemical Division, Food Machinery and Chemical Corp., is now employed as key engineer on combines in the engineering department of the J. I. Case Co., Bettendorf, Iowa.

Donald E. Clark, recently employed in the Munitions Division of Massey-Harris Co., Port Credit, Ontario, resigned to accept employment on the agricultural engineering staff of Ontario Agricultural College, Guelph.

NECROLOGY

Arthur H. Hemker, manager of farm industries sales, General Electric Co., passed away on May 22 while attending the 25th reunion of the Class of 1929, of which he was president, at Kansas State College.

Following graduation, Mr. Hemker joined General Electric on the test course at Schenectady and worked in the turbine, motors and control departments. He later transferred to rural electrification in Schenectady and was in the company's office in Chicago from 1931 to 1933. After three years as a consulting engineer and five years as an industrial engineer for a utility company, he returned to General Electric in 1941 in the central station department, rural electrification section. He joined the farm industries division when it was formed in 1945 and was named manager of farm industries in 1948.

Mr. Hemker received a Kansas State scholarship award in 1926, was a member of Scabbard and Blade in 1928 at Kansas State and of Phi Mu Alpha music fraternity. He was a member of Theta Xi and Sigma Tau.

Mr. Hemker was a past-chairman of the North Atlantic Section of the American Society of Agricultural Engineers, and during the period of his membership in ASAE, which began in 1941, he had been active on a number of its committees, particularly in the rural electrification field.

He was serving this year as program chairman of the National Farm Electrification Conference, the annual meeting of which is scheduled to be held in Schenectady in the fall. He was also chairman of the industry advisory committee of farm electrification research to the U.S. Department of Agriculture. He was also a member of the American Institute of Electrical Engineers, and in local activities had served as president of the Elmer Avenue and City Parent Teacher Association and was also a scoutmaster. He was a member of the Mohawk Club and the Mohawk Golf Club.

Mr. Hemker is survived by his wife, Mrs. Leah Clark Hemker; a son, Arthur, Jr., both of Schenectady; his parents, Mr. and Mrs. Fred Hemker, Great Bend, Kansas; a sister, Mrs. Elfrieda Geil, and four brothers, Herbert H., Walter D., Willard S., and Karl M., as well as several nieces and nephews.

NEW BOOKS

The Flood Control Controversy, by Luna B. Leopold and Thomas Maddock, Jr. Cloth xiii+278 pages, 6 x 9 inches. Indexed. The Ronald Press Co. (15 East 26th St., New York 10, N. Y.) $5.00.

Subtitled "Big Dams, Little Dams, and Land Management," this book sponsored by the Conservation Foundation aims to present and clarify the facts on floods and flood control as a step toward reconciling differences of opinion which result in more controversy than control. Part I presents "The Flood Control Problem," in terms of The Area of Conflict, The River Flood Plain, Administrative Elements of a Flood Control Program, Engineering Measures for Flood Control, Land Management and The Controversy. "Downstream Programs for Flood Control." Part II is discussed in chapters on Flood Control Plans and Their Development and Problems Connected with Downstream Programs. In Part III, "Upstream Programs for Flood Control," chapters deal with The Project Plan, Proposals for Upstream Work and Problems Connected with Upstream Programs. Part IV, "Beyond the Controversy," discusses Roadblocks to Progress and presents a Summary and Interpretation.

History of American Industrial Science, by Courtney R. Hall. Cloth xix + 453 pages. Indexed. Library Publishers (8 W. 40th St., New York 18, N. Y.) $4.95.

Engineers will be generally in sympathy with the announced purpose of this work: "to help make the general public aware of the need for the continued improvement of our industrial system, along the lines of greater productivity and efficiency, and into new lines of helpful development, and to tell the story in terms which most people can understand." While agricultural engineers are not mentioned as such, the importance of engineers and engineering to agriculture is presented briefly in connection with the record of progress in farm mechanization, rural electrification, soil and water control, and related developments. Chapter headings are: From the Beginning, Enter the Industrial State, Transportation in the Twentieth Century: Land and Water, Transportaton in the Air, The New World of Chemicals, The Electrical and Communications Industries, Modern Mining and Metallurgical Industry, The Non-Metallic Minerals, Rubber and Rubber Products, Pulp, Paper and Print, Feeding, Cleaning and Clothing the Millions, Precision in American Industrial Science, Industrial Science and National Defense, and A Year of Industrial Science: Conclusion.

How to Operate Excavation Equipment, by Herbert L. Nichols, Jr. Cloth, viii+150 pages, 6½ x 9½ inches. Illustrated. North Castle Books (Greenwich, Conn.) $2.50.

Here is a guide for operators of excavating equipment, written by an experienced operator and contractor, with a view to serving the additional purpose of helping "sidewalk superintendents" understand what they see. It deals in terms of methods of application, and handling various types of jobs, rather than the variable details of starting and running various makes and types of machines. Chapters cover Revolving Shovels, Conveyor Machinery, Tractors and Dozers, Tractor Loaders, Hauling Units, Graders and Rollers, and Other Work.

Twine trouble—and the rain beat them to the barn.

For want of good twine the crop was lost...

When the hay is ready to come in, delays in baling add up to more than personal inconvenience. Just one hour lost in the field can lose you hundreds of dollars in feed value leached away by a sudden rain. And a poor grade of baler twine that snags, snarls or breaks can do the damage.

What makes a "good" twine? Your best twine is made from the choice fibers of agave sisalana, the true sisal plant which grows in East and West Africa, Haiti and Brazil. Such fibers are hard and tough for strength, flexible for smooth, fast knotting. Yet these natural qualities can be lost through poor curing. So twine specialists grade fiber twice; once when it's bought at the source and again when it reaches the mill.

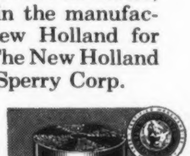
In manufacture, the fibers are blended and combed into alignment through "pin-fields." Then spinning jenneys twist them into twine. If the twist is too tight, the fibers will cut each other when pulled . . . if too loose, they'll slide apart. In either case, you get a low breaking point.

Uniformity saves you money. You buy twine by the pound, but use it by the foot. A thin twine will give you more feet per pound, but it'll break in your baler. A thick twine may be strong, but it gives you too few feet per pound. Good twine gives you both length and strength to tie more tons of hay per bale of twine without breakage.

As builder of the first automatic twine-tie balers, New Holland leads in experience in the manufacture of baler twine. Count on New Holland for good twine that means fast baling. The New Holland Machine Co., a subsidiary of The Sperry Corp.

Certified Baler Twine

New Holland Baler Twine is certified by the U. S. Testing Co., an independent testing laboratory, to meet rigid specifications of length, uniformity, strength. Look for the Seal of Approval on every bale.

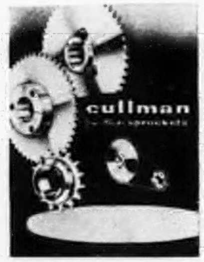


NEW HOLLAND *"First in Grassland Farming"*

NEW PRODUCTS CATALOGS

New Sprocket Catalog

Cullman Wheel Company, 1344 West Altgeld St., Chicago 14, Ill., will send on request to interested readers copies of its bulletin No. 184 presenting up-to-date information on its Gripmaster sprockets, flexible couplings and steel weld-on hubs. The catalog features sections on uses, advantages, adaptability and flexibility of the Gripmaster interchangeable bushing system. A list of authorized distributors of Cullman products is also included.

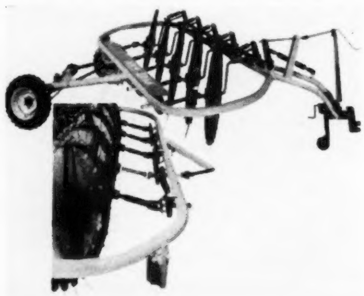


Torque Converter Cooler Catalog

Young Radiator Co., Racine, Wis., and Mattoon, Ill., will send on request to interested readers a copy of its catalog No. 1054 illustrating the Young torque converter line of coolers which are engineered for any mobile or stationary application from 100 to 600 hp, for oil-to-air or oil-to-water cooling of power equipment, using straight hydraulic or hydraulic and mechanically clutched transmissions. The catalog covers specifications, cooling capacities, dimensions and product features, including model illustrations and cutaway views.

New Type Wheel Rake

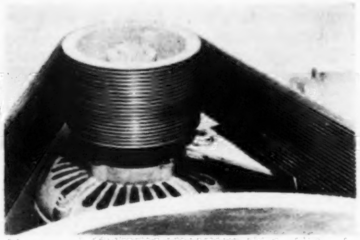
New Idea Farm Equipment Co., Coldwater, Ohio, has introduced a new type of wheel rake with power-driven raking wheels. Unlike conventional wheel rakes, in which the raking wheels are driven by ground contact, this new rake is powered by a live axle driven by the ground wheels.



The power is transmitted from the live axle to a series of jack shafts which drive the five raking wheels. The raking wheels can be individually adjusted to float over the ground thereby avoiding much of the dirt and debris picked up by conventional models requiring ground contact. The hitch on the New Idea rake has a vertical adjustment of 16 inches. It can be connected by a hitch pin to any tractor drawbar at the proper height for good performance.

Multiple V-Belt Drive

Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N. J., has introduced what it believes to be a completely new concept of power transmission which it calls the Poly-V Drive, which is a single, endless rubber belt with a series of parallel V ribs molded lengthwise around the inside circumference and has an uninterrupted,



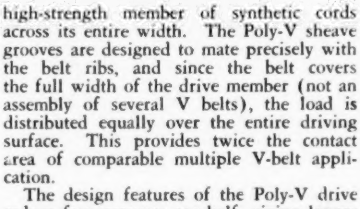
high-strength member of synthetic cords across its entire width. The Poly-V sheave grooves are designed to mate precisely with the belt ribs, and since the belt covers the full width of the drive member (not an assembly of several V belts), the load is distributed equally over the entire driving surface. This provides twice the contact area of comparable multiple V-belt application.

The design features of the Poly-V drive reduce face pressure one-half, giving longer life to belt and sheaves. Also, the full drive width and the total traction surface contact prevents belt turnover and progressive sinking in sheave grooves. One of the most important features of the new drive is that it eliminates belt-matching problems common to multiple V-belt applications.

Belts and sheaves in a range of sizes are now in production, and the Poly-V drive is in the same general price range as V-belt transmission drives for comparable service.

Self-Propelled Combine

International Harvester Co., Chicago, Ill., has announced a new self-propelled combine in 10, 12 and 14-ft sizes, which it is claimed will save more grain due to an opposed-action, double-shake cleaning that prevents grain loss due to straw "bridging" or "piling up" between the chaffer and shoe



sieve. Three-point separation, at concave, finger grate, and a large 21-sq-ft straw rack also helps to save more grain. The machine is equipped with a 6-cylinder, 60-hp engine and a new, variable-speed propulsion drive which provides 28 speeds ranging from 1 to 15 mph.

Other features include extra strength at all points of strain, full-floating axle, dust-proof housing for transmission and differential gears, and a lowered center of gravity and weight distribution to give the machine stability on slopes. Power steering and hydraulic brakes are available as special equipment. The machine is available in a rice model as well as a new "level-matic" hillside machine for level harvesting on steep slopes. *(Continued on page 436)*

New Products and Catalogs

(Continued from page 435)

New Book on Silent Chain

Link-Belt Co., 307 N. Michigan Ave., Chicago 1, Ill., announces that it has published a new 88-page book, containing detailed engineering data on their silent-chain-drive products, which will be sent to interested readers without charge. Requests for copies should specify book No. 2425.

Pre-engineered stock drives for normal requirements are listed in one section, while

another section outlines procedure for selecting completely engineered drives and includes an indexed table of service factors, rating tables, and chain length and center distance computations. Another section on drive components lists available chain widths; chain and wheel dimensions; wheel tolerances, materials, and other pertinent data. There is a section on accessories covering casings and tensioners, and complete operational and technical data are included in the final section.

Flexible Shaft Tree Girdler

Stow Manufacturing Co., 39 Shear St., Binghamton, N. Y., has designed a flexible shaft especially for a new tool for girdling trees. The Haynes tree girdling unit has a

special high-speed cutting wheel that cuts at walking speed, cutting a smooth half-round girdle sufficient in width to insure killing the tree. By use of the flexible shaft, the engine can be mounted on a man's back and transmit full power to the tool.

(Continued on page 438)

Here's why an AUSTIN-WESTERN power grader gives you 30% more power at the blade and twice the maneuverability

Much of the time, All-Wheel Drive and All-Wheel Steer work as a team to provide CONTROLLED TRACTION. In this position, the rear drivers push behind the toe of the blade; the front drivers pull ahead of the heel of the blade, and the machine moves straight ahead with a load on its blade that would cause the ordinary grader to become unmanageable.

On the ordinary front steer, rear drive motor grader, the front end is just that much dead weight which the rear end has to push around. *Total* weight is not the measure of motor grader operating efficiency. What counts is the useful working weight carried on driving wheels; all other weight consumes power, and is a definite handicap.

On the Austin-Western Power Grader, there are no idling front wheels . . . no dead front end to consume power and decrease operating efficiency. All weight is on driving wheels—front and rear—contributing 100 percent to traction. Dynamometer tests, conducted with the greatest accuracy, have proved conclusively that with two graders of the same weight and horsepower, working in first or second gear where real earthmoving is done, an all-wheel drive machine has 30 percent more power-at-the-blade than one with rear drive only.

With its ability to steer both ends of the machine in the same direction or opposite directions, the Austin-Western Power Grader has twice the maneuverability of other graders; works around short-radius curves impossible for machines with front steer only; turns easily on narrow roads and trails, and maneuvers more closely around culverts, bridges and other obstructions.

Spring and Summer, Fall and Winter, the A-W Power Grader outperforms all other motor graders . . . on all types of work, and under all conditions.

Austin-Western

Power Graders • Motor Sweepers
Road Rollers • Hydraulic Cranes

BALDWIN BLH LIMA-HAMILTON
Construction Equipment Division

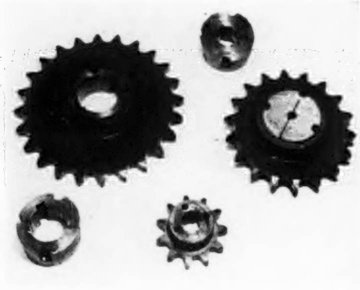
Manufactured by
AUSTIN-WESTERN COMPANY
Subsidiary of Baldwin-Lima-Hamilton Corporation
AURORA, ILLINOIS, U.S.A.

New Products and Catalogs

(Continued from page 436)

Taper-Lock Roller Chain Sprocket

Morse Chain Co., 7601 Central Ave., Detroit 10, Mich., recently expanded its stock taper-lock roller chain sprocket line by adding three larger pitches in single and double-hub types. These sprockets in both single and double-hub types are now available for 1½, 1¾, and 2-inch-pitch chain.



Only five bushing sizes are required to fit the newly expanded line. They are being stocked by Morse distributors in 54 bore sizes. Main advantages of the taper-lock design include fast delivery off-the-shelf from distributors without reboring, easy installation, gripping of both standard and normally undersized shafts with the firmness of a shrink fit, compactness, safety because of no protruding flanges and reusable bushings.

New Model Sprinkler

National Rain Bird Sales & Engineering Corp., Azusa, Calif., announces development of a new sprinkler, to be known as the No. 30-W model, and claims that it will answer the problems of influence of wind

on sprinkler irrigation, as well as excessive wear due to the abrasive action of dirty water. The sprinkler is equipped with new type bearings which incorporate a hood covering the upper part of the bearing. This hood keeps abrasive material out of the sprinkler while it is in operation or lying on the ground.

Cam Clutches Catalog

Morse Chain Co., 7601 Central Ave., Detroit 10, Mich., will send on request to interested readers a copy of its new catalog (C12-54) describing Series 200 Morse cam clutches for indexing, overrunning and backstop machine-drive applications. It gives application data, typical installation drawings, and a complete table of specifications for seven models of clutches having torque ratings from 10 to 500 ft-lb and ground OD dimensions corresponding to standard 200 series ball bearings in nominal sizes from 1½ to 3½ inches outside diameter.

(Continued on page 440)

New Products and Catalogs

(Continued from page 438)

New Dry-Type Micronic Air Filter

Purolator Products, Inc., Rahway, N. J., have placed on the market a new dry-type micronic air filter for both gasoline and diesel engines. Similar in construction to the present Purolator micronic automotive filter for lubricating systems, the new filter is claimed to have many advantages over the standard type of air filter presently in use. Chief among these advantages are a higher degree of filtration, thereby reducing the entrance of air-borne abrasives into an engine; a freer flow of air into the combustion chambers, and, since it is easier and cleaner to service, a greatly reduced serviceability time.

The company claims this dry-type air filter will be a definite aid in helping to reduce engine wear to a minimum.

Torque Limiter Catalog

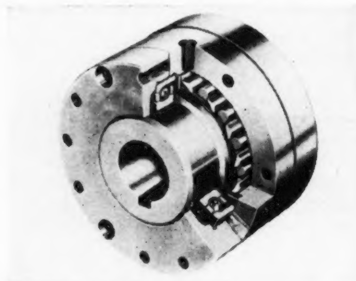
Morse Chain Co., 7601 Central Ave., Detroit 10, Mich., will send on request to readers a copy of its catalog (C14-54) describing Morse torque limiters, compact, adjustable slip-clutch devices that provide automatic overload protection for machinery drives. Complete design and operation information is given in the catalog as well as specification tables for a line of eleven standard models having torque capacities ranging from 20 to 620 ft-lb.

"Irrigation Digest"

McDowell Mfg. Co., Pittsburgh 9, Pa., will on request gladly place any reader of Agricultural Engineering on its mailing list to receive its bimonthly publication "Irrigation Digest."

General Duty Cam Clutches

Morse Chain Co., 7601 Central Ave., Detroit 10, Mich., announces that a new line of general-duty, heavy-duty ball-bearing overrunning clutches has been added to their line of standard cam clutches. These self-contained units include two ball bearings that maintain concentricity of



the inner and outer races, thus avoiding the need for additional bearings to support the ends of shafts that the clutches control.

Typical drive applications of these clutches have alternate low wedge angle cam and roller construction and include high-speed overrunning and backstop (anti-rotation) applications as well as heavy-duty indexing. They can be used as indexing mechanisms in spring coilers, stock feeds and tire cross-grooving machines. Two-speed drives are typical overrunning applications for these clutches. They can also be used in heavy-duty backstop mechanisms.

Only one with all this!

Only Oliver offers so many "most-wanted" advancements in a farm wheel tractor!

Only Oliver builds both gasoline and "full" diesel models in *all* power classes—2-plow, 2-3 plow, 3-4 plow, 4-5 plow.

Only Oliver tractors are powered by smooth, 6-cylinder engines in *all* these big-tractor categories—2-3 plow, 3-4 plow, 4-5 plow.

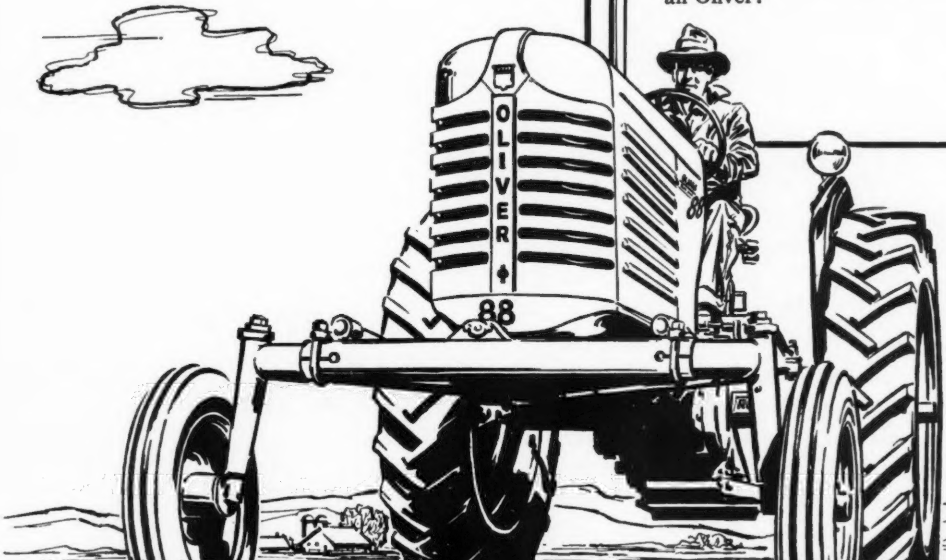
Only Oliver provides six forward speeds in *all* three popular sizes—2-plow, 2-3 plow, 3-4 plow.

Only Oliver equips *all* its tractors with a really comfortable rubber spring seat at no extra cost.

And, on *all* Oliver tractors are safe, long-lasting disc brakes, metered, low-pressure lubrication systems that save oil during the tractor's entire life, and by-pass cooling that permits uniform warm-ups.

Then, look what's available for the great Row Crop line—an *independently controlled* Direct Drive Power Take-Off...a "Hydra-lectric" control system that includes working-depth adjustment from the tractor seat ...and a full line of mounted tools that are basically interchangeable among *all* three models.

The *only* tractor for the modern farm is an Oliver!



The OLIVER Corporation F29-6
400 West Madison Street
Chicago 6, Illinois
Please send me information on Oliver Tractors.

Name...
(Please Print)

Post Office...

R.R..........County..................State.........

OLIVER

"FINEST IN FARM MACHINERY"

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Adams, James R.—Student in agricultural engineering, University of Tennessee, Knoxville, Tenn. (Mail) 235 So. Stadium

Aldrich, Robert A.—Instructor and junior agricultural engineer, Washington State College, Pullman, Wash.

Baardson, Andrew B.—Dealer program director, Harvestore Division, A. O. Smith Corp., Milwaukee 1, Wis.

Bazzetta, James—Field engineer, Caterpillar Tractor Co. (Mail) Via Gennargentu 20, Int. 9, Rome, Italy

Bledsoe, Bobby L.—Layout draftsman, International Harvester Co. (Mail) RR 3, Dyersburg, Tenn.

Blevins, Frederick Z.—Field representative of the technical service branch, Allied Chemical & Dye Corp. (Mail) 8-7 Ross Ade Dr., West Lafayette, Ind.

Bohara, Kamalesh N.—Foreman, agricultural engineering section, Government of Madhya Bharat (Mail) Agricultural Engineering Workshop, Madhya Bharat, Gwalior (India)

Chancellor, William J.—Student, University of Wisconsin (Mail) RR 1, Mount Horeb, Wis.

Cole, William R.—Manager, Fence Builders & Farm Construction, Inc. (Mail) 143 S. Grant St., West Lafayette, Ind.

Coleman, Leonard O.—Agricultural engineer (SCS), USDA, Brownfield, Tex. (Mail) 1002 E. Hester

Crawford, Todd V.—2nd Lt., USAF (Mail) 146½ S. Doheny Dr., Beverly Hills, Calif.

Diamond, John L.—Sales development division, Caterpillar Tractor Co., Peoria, Ill. (Mail) 221 Parish

Dresser, John C.—Student at Iowa State College, Ames, Iowa (Mail) Box 313 Friley Hall

Easter, Ray C.—Student, Montana State College (Mail) Norris, Mont.

Fridman, Harry L., Jr.—Service manager Clemente Santisteban, Inc., Box 891, San Juan, Puerto Rico

Gehl, William B.—Experimental engineer, O. W. Kromer Co. (Mail) 4252 Chowen Ave., N., Robinsdale, Minn.

Gustafson, Carl R.—Farm service director, Otter Tail Power Co., Fergus Falls, Minn. (Mail) 422 W. Vernon Ave.

Hall, Warren A.—Assistant professor of irrigation, University of California, Davis, Calif.

Haupt, Robert C.—Student, University of Nebraska (Mail) Cortland, Nebr.

Helmreich, Fritz W.—Graduate student, department of soil science, Michigan State College, East Lansing, Mich. (Mail) 376 W. Shaw Hall

Herrington, Jack D.—Architect, Agricultural Engineering Research, USDA. (Mail) 3424 Tulane Dr., Apt. 12, West Hyattsville, Md.

Hirzel, Rudolph W.—Graduate research assistant in agricultural engineering, Michigan State College, East Lansing, Mich.

Jenkins, William H., III—Assistant shop superintendent, Southeastern Liquid Fertilizer Co., Albany, Ga. (Mail) 709 Flint Ave. *(Continued on page 444)*

Minnesota Welcomes You

To the 1954 ASAE Annual Meeting, June 20-23, University of Minnesota, Minneapolis

Applicants for Membership

(Continued from page 442)

Johnson, Boyd W.—Student, Montana State College (Mail) Choteau, Mont.

Johnson, Lowell S.—Project engineer, J. I. Case Co., PO Box 1848, Stockton, Calif.

Kruger, Warren E.—Student, Montana State College. (Mail) 565 6th Ave., Shelby, Mont.

Larson, Orton E.—Student, North Dakota Agricultural College, Fargo, N.D. (Mail) C-2 N. Court

Massey, William R.—Lab assistant in agricultural aviation research, Personal Aircraft Research Center (Mail) 1108 W. 27th St., Bryan, Tex.

Miller, Winford A.—Student, Oklahoma A. & M. College, Stillwater, Okla. (Mail) 610 Hester, Apt. 4

Minshall, Neal E.—Project supervisor (ARS), USDA, Madison 5, Wis. (Mail) 4310 Tokay St.

Minto, Stanley D.—Senior agricultural engineer, Overseas Food Corp. (Mail) c/o Experimental Station, O.F.C., Urambo, Tanganyika, E. Africa.

Myers, Herbert A.—Graduate student and instructor in agricultural engineering, Iowa State College, Ames, Iowa

Nelson, Irving J.—Agricultural engineer (SCS), USDA, Hot Springs, Mont. (Mail) Box 603

Overstreet, Reading—Partner, Overstreet & Kininmonth Agricultural & Industrial Sales, Phoenix, Ariz. (Mail) PO Box 2406

Pira, Edward S.—Instructor in agricultural engineering, University of Massachusetts, Amherst, Mass. (Mail) Engineering Annex

Powers, Alfred X.—Instructor in agricultural engineering, University of Massachusetts, Amherst, Mass.

Rogers, James H.—Plant maintenance engineer, Colgate and Palmolive Co. (Mail) 1718 New Boston Road, Texarkana, Tex.

Ruffini, Harry R.—Student, Texas A. & M. College (Mail) Av. Presidente Masarik 123, Mexico City, Mexico

Scheneman, Carl N.—Extension assistant professor of agricultural engineering, Columbia, Mo. (Mail) 200 Agricultural Engineering Bldg., University of Missouri

Self, Neal W.—Product engineer, J. I. Case, Anniston Works, Anniston, Ala.

Spellman, Clark P.—Director of area development department, Virginia Electric and Power Co., Richmond, Va.

Stough, John M.—General manager, Hy-way Concrete Pipe Co., PO Box 226, Findlay, Ohio

Sundberg, Charles W.—Project engineer, Armament Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base (Mail) 1007 Amherst Pl., Dayton 6, Ohio

Vilander, Dean R.—Student, State College of Washington (Mail) 2500 Broadway, Vancouver, Wash.

Weaver, Homer A.—Agricultural engineer (ARS), USDA, Auburn, Ala. (Mail) PO Box 962

Weiner, Ernest H.—Editor, Western Farm Equipment, 609 Mission St., San Francisco, Calif.

Williams, Oren R.—Sales manager, steel and coal department, Indiana Farm Bureau Cooperative Assn., Inc., 47 S. Pennsylvania St., Indianapolis 9, Ind.

Young, George D.—U. S. Army (Mail) 204 S. Parker St., Bryan, Tex.

Zakiyah, Adib M.—Agricultural engineer, Ministry of Agriculture, Damascus, Syria (Mail) Box 5217, College Station, Tex.

Transfer of Membership Grade

Garner, Warren E.—Assistant agricultural engineer, University of Georgia, Athens, Ga. (Associate Member to Member)

Knight, St. Clair, Jr.—Agricultural engineer, Duke Power Co., Spartanburg, S. C. (Associate Member to Member)

White, James W.—Agricultural research officer, Central Experimental Farm, Canada Department of Agriculture, Ottawa, Ontario, Canada. (Mail) Agricultural Engineering Section (Associate Member to Member)

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings still current and previously reported are not repeated in detail; for further information see the AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN — JANUARY — O-488-549, 491-550, 494-551. FEBRUARY — O-19-602. MARCH — O-65-603, 66-604, 67-605, 62-608, 74-609. APRIL—O-90-613, 98-614, 106-615, 102-616, 116-617, 134-618. MAY—O-131-619, 149-620, 150-621, 151-622, 155-623, 108-624, 162-625, 173-626.

POSITIONS WANTED — 1953 — DECEMBER — W-405-80, 451-87. 1954—JANUARY—W-456-88, 490-90, 484-91. FEBRUARY—W-5-102, 20-103, 24-105, 25-106, 45-107, 46-108. MARCH—56-112, 54-113, 37-116, 64-117, 78-118. APRIL—W-86-119, 84-120, 96-122, 93-123, 109-124, 124-125, 125-126, 107-127. MAY—W-122-128, 146-129, 128-130.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER, junior or intermediate vocational instructor. Age 25-45. BS deg in agricultural engineering or equivalent required. Higher degree preferred. Farm background and some experience in farm equipment industry, teaching, or research. Good personality, ability to cooperate and get along well with others, and imagination to develop outstanding program. Emphasis on practical instruction using 3000-acre college farm as a laboratory. Applicants should be qualified to teach field operation, adjustment and maintenance of farm machinery, and courses for agriculture teachers in summer session. Opening effective September 1. Salary range $3900-4740 or $4512-5496, according to rank, training and experience. O-180-627

MIDWEST CORPORATION with over 50 years experience wants promotional and development man to head well established and complete line of crop drying equipment. Position is one of top men in firm with excellent pay and profit sharing plans. Write giving a brief description and background of experience. O-181-628

AGRICULTURAL ENGINEER for design and development work with Midwest manufacturer. Excellent opportunity for experienced, qualified individual possessing executive value for engineering responsibility. Age 35-50. Salary open, depending upon experience and qualifications. O-197-629

AGRICULTURAL-MECHANICAL ENGINEER for research field. Interested or experienced in determining the relationships between soils and vehicles with respect to vehicle mobility research. Mathematical facility desirable. Must have the ability to analyze reports, data and other material; write technical reports; make presentations in a concise, simple form to the board of governors. Should have initiative, dependability, good judgment. Salary open, depending on qualifications. O-198-630

AGRICULTURAL ENGINEER (assistant professor) to teach farm power and machinery and farm structures in a southern land grant university. Age 25-35. BS deg in agricultural engineering, or equivalent. Advanced degree and some experience desirable. Good opportunity for advancement O-182-631

JUNIOR PRODUCT ENGINEER for development, improvement, field testing and preparation for production of farm machinery, including forage harvesters and other feed handling and processing equipment. Location, New York State. Age 22-30. Degree in agricultural or mechanical engineering, or both. Livestock farm background, familiarity with use of machinery and previous employment in farm equipment engineering desirable. Intelligence, good health, and ability to work with factory, office, and farm personnel. High mechanical aptitude, with sound knowledge of engineering principles. Good opportunity for eventual advancement to chief product engineer. Reliable, long-established company in rural area. Salary $4200-5200 plus share in profits and other benefits. O-200-632

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for design and development work with manufacturer, preferably in Northeast. Willing to travel. Married. Age 34. No disability. BS deg in agricultural engineering, 1949, Pennsylvania State College. One year on design and development of manure loader. Service engineer 3 yr with farm machinery distributor. Available now. Salary open. W-115-131

AGRICULTURAL ENGINEER for design, development, or research in power and machinery or soil and water field, with manufacturer, processor, or consultant in Midwest or Southwest. Interested in further training for management. Married. Age 24. No disability. BS deg in agricultural engineering, 1952, Oklahoma A & M College. Farm background. Surveying and land development work 10 wks. Commissioned service in U.S. Air Force, 2 yr in August, in administration and management on a classified research and development project. Available September 1. Salary $5000. W-159-132

TEACHER OF INDUSTRIAL MANAGEMENT or education for industry, with federal agency or college, preferably in North or East. Single. Age 24. No disability. BS deg in agriculture with major in agricultural engineering, 1951, MA deg in education with major in education for industry, 1952, University of Maryland. Farm background. Part time laboratory assistant, 2 yr., University of Maryland. Active commissioned service over 2 yr., U.S. Air Force, with duty as adjutant, personnel officer, investigator, and production control officer. Available in August. Salary open. W-164-133

AGRICULTURAL ENGINEER with special training in soils, for design, development or research in soil and water field, or surveying, with industry, anywhere in U.S.A. Single. Age 24. No disability. MS deg in agricultural engineering, 1953, University of Agriculture, Vienna, Austria. MS deg in soils expected in August, Michigan State College. Experience 11 mo with department of drainage, irrigation and flood control, Government of Lower Austria. Available September 1. Salary $4000. W-169-134

AGRICULTURAL ENGINEER for design, development or research in power and machinery, with public service or industry. Married. Age 29. No disability. BS deg in mechanical engineering, 1949; MS deg in agricultural engineering, 1951, King's College, University of Durham, England. Shop work with manufacturers of farm equipment and aircraft, 2 yr. Soil conservation officer 2 yr and agricultural engineer one year, with department of conservation and extension, Southern Rhodesia. War service in RAF as pilot of flying boats. Available in October. Salary open. W-141-135

(Continued on page 448)

Index to Advertisers

Personnel Service Bulletin

(Continued from page 446)

AGRICULTURAL ENGINEER for design, development, sales, or service in power and machinery or farm structures field, in industry or public service anywhere in U.S.A. Limited travel. Married. Age 31. No disability. BS deg in agricultural engineering, 1943, University of Georgia. MS deg in agricultural engineering, 1947, Iowa State College. Research in farm buildings and rural housing 3 yr. Sales engineer on portable irrigation equipment. War enlisted and commissioned experience in Army, Armored Force, nearly 3 yr. Available July 1. Salary open. W-179-136

AGRICULTURAL ENGINEER for research, development, or sales engineering in agricultural aviation with industry or public service in South Central U.S. Age 30. No disability. BS degree in agricultural engineering with Soil Conservation option, southern university, 1949. Experience as district supervisor with major tractor and equipment distributor, demolishing contracting, and crop dusting. Hold valid CAA rating in single engine and helicopter aircraft. Will consider flying. Previous three years active duty as Lt., Navy. Available July 15. Salary open. W-199-137

Professional Directory

RATES: 80 cents per line per issue; 40 cents per line to ASAE members. Minimum charge, five-line basis. Uniform style setup. Copy must be received by first of month of publication.

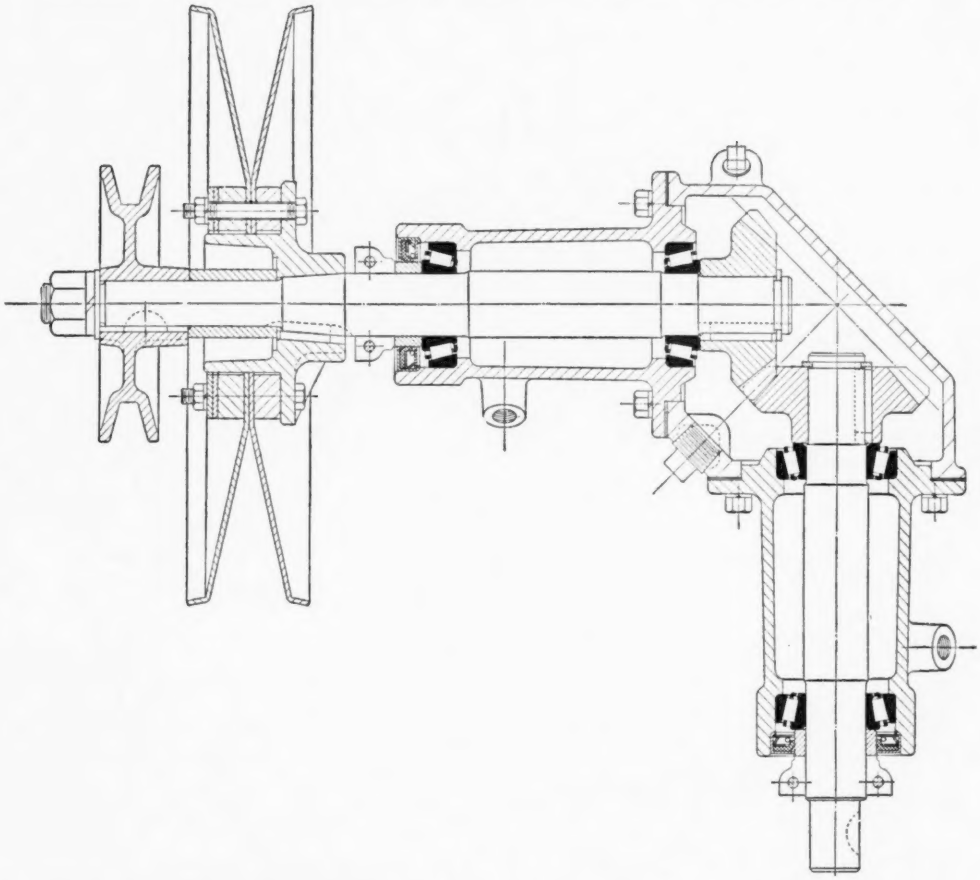
Editorial Position

Well-established technical magazine is seeking graduate engineer under 45 years of age, with farm background, to fill responsible editorial position. Must have ability to do technical editing, as well as original writing, rewriting, and abstracting. Location Midwest. Position permanent. Good opportunity for advancement to larger editorial and general publishing responsibilities. Send complete resume of experience, education, salary required, and references. Address Box ED-554.

AMERICAN SOCIETY OF
AGRICULTURAL ENGINEERS

ST. JOSEPH, MICH.

How Allis-Chalmers Handles Heavy Combination Loads in a Harvester Drive



IN this Allis-Chalmers harvester the drive comes from the main harvester through the vertical shaft and goes out the horizontal shaft to drive the cylinder and the header through the V-belts.

One ot the problems for Allis-Chalmers engineers was mounting the gear shafts. They turn at fairly high speeds, 750 rpm, and the loads are heavy enough to make ordinary bearings fail in a short time.

To meet these conditions, Allis-Chalmers mounted the shafts on Timken® tapered roller bearings. The bevel gears develop heavy thrust loads as well as radial loads. Timken bearings take these combination loads because ot their tapered design. No additional thrust devices are required. Timken bearings hold the gears in accurate alignment which reduces gear wear, forestalls trouble.

These gears run in a bath ot oil, so good bearing closures are especially important. Timken bearings hold the shafts concentric in their housing; this makes for more effective closures. Oil can't leak out or dirt get in.

Dirt and combination loads are two important problems Timken bearings help solve. A third: ease of operation. Timken bearings cut friction to a minimum, make equipment run smoother and last longer.

Do you have our helpful booklet "Tapered Roller Bearing Practice in Current Farm Machinery Applications"? Write for a free copy. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

The farmer's assurance of better design

TIMKEN Tapered Roller BEARING EQUIPPED

NOT JUST A BALL ◯ NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION